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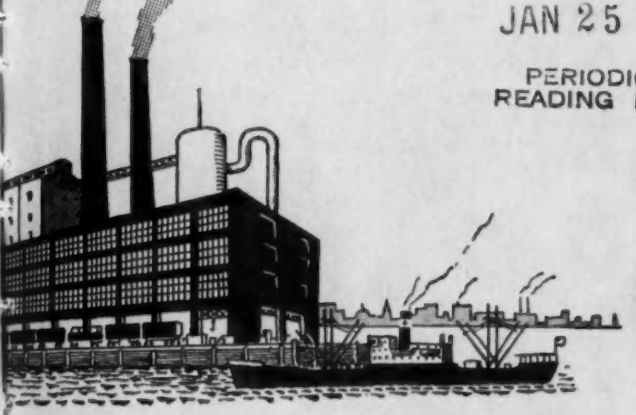

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ECONOMIC GEOGRAPHY

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SOME PROBLEMS AND TECHNIQUES IN ISOPLETH MAPPING

J. Ross Mackay

Assistant Professor Mackay (Ph.D., University of Montreal, 1949) of the Department of Geology and Geography, University of British Columbia, is especially interested in cartography and in geography of the Far East. His "Dotting the Dot Map" appeared in SURVEYING AND MAPPING *in 1949.*

ONE of the cartographic developments which has characterized geographic research in recent decades has been the increasing use of distribution maps. Few studies in regional or economic geography are really complete without quantitative distribution maps to show areal differentiation of elements such as people, land, and crops. In the present discussion an attempt is made to analyze some of the problems and techniques concerning the isopleth map, which is one type of quantitative distribution map.

A number of different words have been used, both in geography and other disciplines, for line symbols which represent various kinds of constant values on quantitative distribution maps.[1] A proposal has recently been made by J. K. Wright that all line symbols be included within the general category of *isograms* with a division into two classes, namely *isopleths* and *isometric* lines.[2] The terminology has certain advantages, because the distinctions between isopleths and isometric lines are of considerable importance: they are based upon different mathematical concepts; require separate cartographic techniques in plotting; and are subject to their own special problems in map interpretation.

Those isograms which pass through *ratios for areas* are isopleths, whereas those through *continuous values for points* are isometric lines. A familiar example of a map utilizing isopleths is the density of population map, while one with isometric lines is the contour map. The preceding terminology is not, however, generally recognized as standard usage. For instance, some authors employ isarithm for what is here defined as an isopleth or isometric line and sometimes it is even used as the equivalent of isogram.[3]

The general inclusive term of isogram means simply "equal-line" but the derivations of isopleth and isometric are suggestive of their differing qualities. Isopleths or "equal-quantity" lines are drawn with reference to data given for statistical divisions such as a township or county. The source data for these lines are obtained mainly by various methods of enumeration and the "quantity" of an isopleth is that of the areal strip through which it passes. For

example, we can only comprehend a density of 20 people per square mile for the areas contiguous to the 20 isopleth because density, which denotes number per unit area, must clearly be viewed against an areal background and not along a factitious line. Isometric or "equal-measure" lines are drawn with reference to "measures" at specific points. The source data are obtained principally by measurement, frequently by instrumental means. The "measure" of an isometric line contrasts strikingly with the "quantity" along an isopleth; for instance, the elevation along a 20 foot contour line is something real and quite different from that of the density of 20 people per square mile along the 20 isopleth.

CLASSIFICATION OF ISOPLETH MAPS

The classification of isopleth maps used here is based upon the types of ratios shown by these maps. The word "ratio" is not restricted to its limited mathematical meaning where the dividend and divisor are in the same units, but refers to a "Fixed or approximate relation, as between things or to another thing, in number, quantity, or degree; rate; proportion." (Webster). The ratios which are recorded by isopleth lines express the relation between one kind of data and another, such as population and land, acres in wheat and acres in cultivated land, or miles of road and number of farms.[4] In each instance the ratios are derived from the proportion of a dividend to a divisor and it is upon the characteristics of these that the system of classification is based. It is realized, of course, that some borderline types are difficult to classify according to the proposed system, but they are relatively few in number.

In the first type, the dividend and divisor are either in the same unit, or the dividend is included within the broader category of the divisor. As an illustration, the dividend may be horses, and the divisor either horses or farm animals. Since the dividend is a part of the divisor, this type of isopleth map shows proportions and percentages, such as ½ or 50 per cent of land in wheat. Many common distribution maps are of this kind.

The second type has the dividend and divisor in unlike units, with the divisor the total area of the statistical division. The reason for the limitation in the divisor is that these maps are distinct from those density maps where the divisor comprises only a portion of the total area of the statistical division. The essential difference between the two becomes evident in the results which may be obtained through map interpretation. As an illustration, since population density $= \frac{\text{people}}{\text{area}}$, the approximate population in any area may be easily computed by multiplying area and density. On the other hand, if the divisor is a portion of the area of the statistical division, such as in a map of the population density per square mile of cultivated land, there is no means of determining either the number of people or the area of cultivated land in any region. The map merely expresses a ratio, and the population may be numerous or few and the cultivated land large or small. Thus a map of population density is included in the second category, while one of the population density per square mile of cultivated land is excluded.

Before a density of population map can be drawn, the area of each statistical division must be known. This information is often difficult to obtain, even though the boundaries are delimited on maps. The reason is that areas enclosed by the boundaries may exceed those to which the statistics apply. For example,

the incorporated area of a city must be subtracted from that of the township in which it lies if a map is to be drawn of rural population density, because statistics for rural population are given only for the unincorporated areas. An excellent illustration of the problems involved is that of determining the areas of census subdivisions for the decennial censuses of Canada. The areas of the census subdivisions are not in the census volumes, although their boundaries have been delimited on some maps. In such cases, the cartographer may frequently select a plotting method which is independent of areas and use dots or some other symbol placed within the boundaries instead of isopleths.

The dividend and divisor in the third and last type are in different units. Since there is virtually no limit to the choice of units for either one, the variety of possible ratios is indeed great. Not all ratios which may be calculated are, however, significant; there is no meaning in a map showing the number of telephone poles per acre of potatoes for the United States. On the other hand, there are a great many ratios which are significant, and in this third type we can expect the greatest progress in the development of new and meaningful ratios.

The drawing of an isopleth map is not a simple and straightforward procedure, although it is often treated as such. It is frequently subject to greater individual variations in judgment and skill than is usual with isometric maps. This arises from several different factors inherent in each type of map. In drawing an isometric map, the cartographer does not choose the positions of the numbers which he is plotting and he is often guided in his placement of lines by a knowledge of the distribution which he is mapping. Thus the draftsman of a contour map is aided by his "topographic sense." In isopleth mapping, the cartographer deals with ratios for areas and not points, and he cannot always rely upon any "sense" to assist him in the placement of his lines.

The problems which require particular attention in isopleth mapping are the locating of the control points (the points which are chosen as representative of the statistical divisions), placing of the isopleths, selecting the isopleth or class intervals, and the reliability of the ratios.

TABLE I

ISOPLETH MAPS SHOW DIFFERENT TYPES OF RATIOS

Types	*Dividend and Divisor*	*Examples of Ratios*
Percentages, Proportions	Same units or with dividend a portion of the divisor	$\frac{\text{20 acres wheat}}{\text{200 acres cultivated land}} \times 100 =$ 10% of cultivated land in wheat
Density	Different units with the divisor the total area of the statistical division	$\frac{\text{3500 people}}{\text{100 square miles}} =$ population density of 35 people per square mile
General ratios; value of distribution, number, size, yield, etc.	Different units	$\frac{\text{3500 people}}{\text{70 square miles of cultivated land}} =$ population density of 50 people per square mile of cultivated land
		$\frac{\text{14,000 acres in farms}}{\text{100 farms}} =$ average size of farm of 140 acres
		$\frac{\text{260 bushels of oats}}{\text{10 acres in oats}} =$ yield of 26 bushels of oats per acre

LOCATING THE CONTROL POINT

There can be little divergence of opinion in selecting the control points where the statistical divisions are symmetrical in shape with distributions assumed to be even. In the familiar rectangular division, the control point would be placed at the intersection of the diagonals. Frequently, however, statistical divisions are irregular in shape, especially in countries or areas where surveys followed long after settlement; in such cases, the grid pattern of land subdivision was rarely used. In addition to irregularity in shape, an uneven distribution will also influence the selection of the position for the control point.

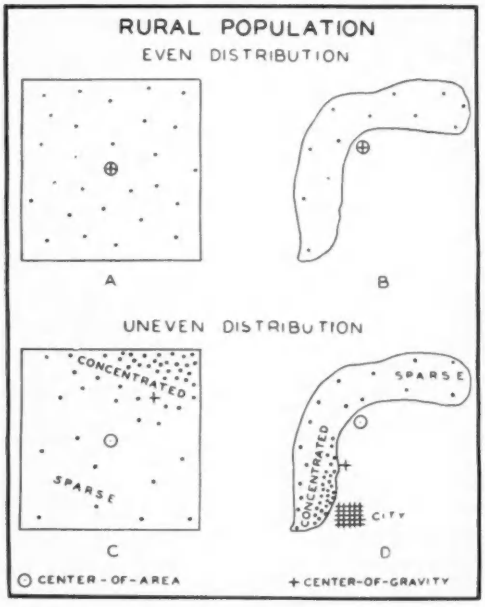

FIG. 1. The four diagrams of statistical divisions show possible locations of the center-of-gravity and center-of-area for uniform and variable distributions, with rural population used as an example. They serve to illustrate the problem of locating the control point in regular and irregular shaped divisions. In A, which is rectangular, the center-of-gravity and center-of-area clearly coincide at the intersection of the diagonals. Because the distribution is even, the centers in B also coincide, but they lie outside the bean-shaped area at a point which is more representative of the whole division than any point within it. The distributions are uneven in C and D so the center-of-gravity is displaced away from the center of area. In each case, however, the center-of-gravity is probably the most accurate location for the control point.

Whether regular or irregular in shape, even or uneven in distribution, the most representative point is probably the center-of-gravity or pivot point where the distribution would balance if it were supported by a rigid and weightless plane.[5] For example, the center-of-gravity for the population of a township would be the point of balance if the total population were supported by a rigid and weightless plane, each person exerting an influence on the center-of-gravity proportional to his distance from it.

If the distribution is assumed to be even throughout a statistical division, the center-of-gravity coincides with the geographical center-of-area (Figure 1, A and B). The center-of-area is the special case of the center-of-gravity where the distribution is even or uniform. The center-of-area for any shape of figure is the pivot point on which it would balance if it were cut out of some uniform material such as cardboard and supported by a rigid weightless plane.

The center-of-gravity is not the only possible kind of center, although it is probably the most accurate and easily calculated type which is suitable for determining the position of the control point. There is, for instance, the bisector-center-of-area which is located at the intersection of two lines which bisect the area. The bisectors are usually chosen to intersect at right angles, such as in the meridian-parallel grid system. The orthogonal bisectors divide the area so that half lies on each side of each line. There are two main disadvantages to this type of center. In the first place, different centers may be obtained by varying the bisectors and so there may be numerous centers.[6] In the second place, the center is adaptable only to the case of an even distribution and is

not suited to an uneven case. On the other hand, there is only one possible center-of-gravity for an area and the center is equally suited to a uniform or variable distribution.

Another type of center which has been especially popular in studies of population movements is ". . . the point at which the entire population could assemble with the minimum aggregate travel, each individual travelling directly."[7] Although normally applied to population analyses, the method may be used in other kinds of areal investigations. The advantages of this type of center are outweighed in isopleth mapping by the fundamental disadvantage of difficult calculation. It is much easier to estimate visually the center-of-gravity, with which everyone is more or less familiar, than that of the unfamiliar center-of-minimum-aggregate-travel.

If the distribution in a statistical division is assumed to be even, the center-of-area will usually lie within its boundary. If, however, the division is irregular in shape the center may lie *outside* rather than inside its boundary (Fig. 1-B). When the center-of-area lies outside the division, such as frequently happens in a bean-shaped area, it is generally preferable to place the control point at the center-of-area instead of arbitrarily keeping it within the boundary of the division. The outside point may be far more representative of the whole division than any point which may be selected within it.

When the distribution is uneven, the control point should, if possible, be placed at the center-of-gravity. The center-of-gravity will be displaced away from the center of area, the amount of displacement varying with the distribution (Fig. 1-C and 1-D), although sometimes the two may coincide purely by chance. It is generally difficult, if not impossible, to determine the precise location of the center-of-gravity but nevertheless it is probably better to shift the control point towards its estimated position than to ignore it completely. A detailed knowledge of the distribution which is being mapped will often assist the cartographer in judging where the center-of-gravity should be located.

In some statistical divisions there are negative regions, such as lakes and

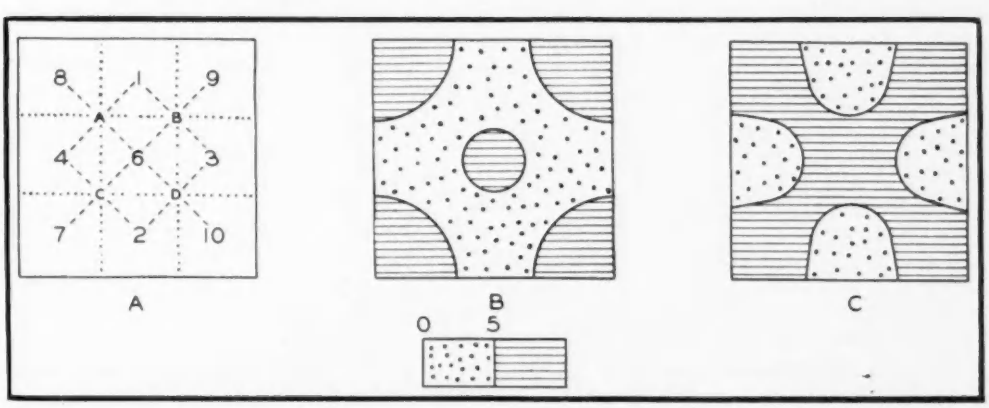

FIG. 2. The nine control numbers in diagram A have been chosen so that certain "pairs" of control numbers are above 5, and others are below 5. When the value of a number intermediate between four control points is being interpolated, it may be considered as above or below 5, depending upon the "pairs" of control numbers used in determining its value. Diagram B has been drawn on the assumption that the values of the numbers lying between control points are below 5, and diagram C with the numbers above 5. Since there is no supplementary information which may be used in making a choice, the matter is entirely one of personal judgment and many maps could be drawn from the same data.

swamps, where the distribution which is being mapped may be sparse or absent. Allowances can be made for some negative regions in dotting dot maps, but the problem of compensating for them is difficult with isopleths. Under most conditions, small features such as lakes cannot be shown on a black and white map without danger of having them confused with the isopleths. There is virtually no means of refining the accuracy of isopleth maps by making adequate provision for the elimination of small negative regions such as may be done with dot maps.[8]

When the control points are sufficiently numerous so that the map distances separating them are relatively small, the problem of locating the control points by the center-of-gravity method is of little to no practical importance. Any small shifting of the control points would be negligible in their effect on the accuracy of the map and the positions of the isopleths. The necessity for precision in locating the points increases with their separation and the scale of the map. It becomes of paramount importance in large scale maps with few control points. In such cases the accuracy of the map is determined not only by the statistics but also by the care with which the control points are located.

PLACING THE ISOPLETHS

An isopleth line is positioned by interpolation and inference with reference to numbers at control points. If every location on a map had only one possible value, then isopleths could be plotted easily by linear interpolation. Unfortunately for the accuracy of the map this is often not the case. There are two possible values for every position which lies between opposite "pairs" of control numbers if one pair lies above, and the other below, the value of an isopleth (Fig. 2-A).

In Fig. 2 there is an illustration of the problem which continuously plagues the cartographer in the placement of isopleths. The numbers at positions A, B, C, and D can be considered as greater or less than 5 depending upon which pairs are used for interpolating their values. Thus the number at A could lie between 1 and 4, or 8 and 6; similarly, those at B, C, and D could lie above or below 5. Since each of the four numbers at A, B, C, and D could be considered with equal validity—in the absence of other evidence—as either above or below 5, a total of 16 different isopleth maps could be drawn by using only the

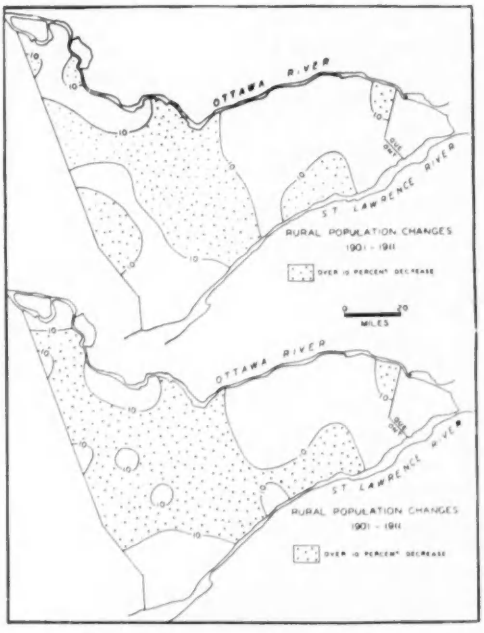

FIG. 3. The theoretical problem illustrated in Figure 2 is shown by two practical examples in these two maps which have been drawn from the same census data. Wherever a number could be considered as either above or below 10, it was chosen as below 10 in the top map and above 10 in the bottom map. In this particular case, supplementary information could be obtained by studying rural population changes in the preceding and following decades. With this information as a guide, a fairly accurate estimation could be made of the values which should be accepted or rejected.

5 ratio (Fig. 2-B and 2-C are two examples).

Another example is given in Fig. 3 which shows 10 per cent isopleths for the decrease in rural population in Eastern Ontario during the decade from 1901 to 1911. The two maps in the figure have been drawn from the same census data but wherever a number could be either above or below 10, it was considered below 10 in the top map and above 10 in the bottom map. As a result, the 10 per cent isopleths differ considerably between the two maps. Neither is better than the other and the best map would be a conpromise between them. If two competent individuals were to draw the isopleths without any supplementary information to assist them, it is clear that dissimilar maps would result.

In drawing many isopleth maps, there is frequently little information to aid the cartographer in placing the control points at the centers-of-gravity although it is known that the distribution is uneven. Nevertheless, he may be able to shift the isopleths to more accurate locations by studying the general distribution and values of the control numbers. As an illustration, rural population density increases near large cities and the cartographer can take this generally known fact into account in the placement of the lines; another example would be where control numbers at equally-spaced control points change rapidly in one direction, such as 10, 20, 40, 80, and 160. It is evident that linear interpolation would be inaccurate, because number 15 is almost certainly nearer to 20 than to 10; 30 to 40, than to 20; 60 to 80, than to 40; and 120 to 160, than to 80.

SELECTING THE ISOPLETH INTERVAL

Selecting the isopleth interval presents a problem to a cartographer comparable to the arrangement of camera, light, and subject to a photographer. In each case, the results can be varied and controlled within limits in order to achieve certain desired effects. A cartographer can utilize his choice of isopleth or class intervals to produce a graded sequence of maps which will vary greatly at the extremes, although all were drawn from the same data.[9]

If numerous isopleths are plotted with small class intervals on a map with widely separated control points, the reader is given a false impression of high accuracy. If the intervals are excessively large with reference to the control numbers and points, significant variations in distribution may be lost in a generalized and featureless map. If the intervals increase or decrease, ratios at the lower or upper end of the scale

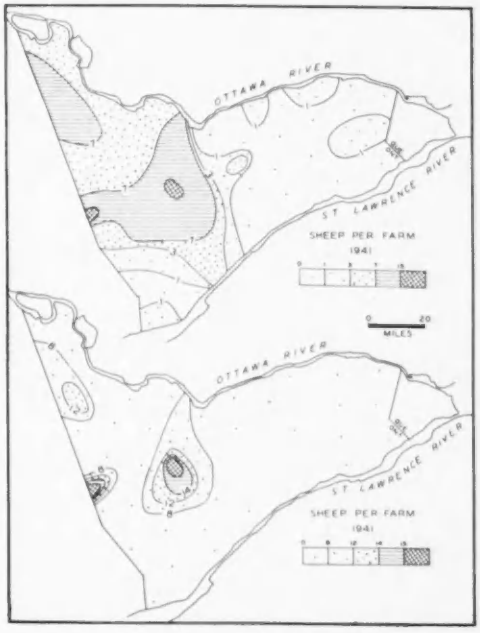

FIG. 4. These two maps have been drawn from the same ratios but with different class intervals. Those in the top map increase in steps of 1, 2, 4, and 8, whereas those in the bottom map increase in the reverse order, namely 8, 4, 2, and 1. The result is to accentuate areas with few sheep per farm in the top map and those with many sheep per farm in the bottom map.

will be emphasized. The two maps of sheep per farm in Fig. 4 have been drawn from the same ratios except with different class intervals. Those in the top map increase in steps of 1, 2, 4, and 8, while those in the bottom map are the reverse order, namely 8, 4, 2, and 1. The result is to accentuate areas with few sheep per farm in the top map and those with many sheep per farm in the bottom map.

Isopleth intervals are often chosen in arithmetic or geometric progression, but are also varied in no systematic manner, such as in 0, 5, 10, 50, and 100. There is a practical limit to the complexity which may be introduced into the class intervals, because map interpretation becomes too difficult if they deviate excessively from a simple pattern.

As an aid in selecting isopleth intervals, the ratios may be plotted in graph form. A convenient method is to use a frequency graph where the number of cases (the frequency) is plotted along the Y-axis and the ratios along the X-axis.[10] The frequency graph will show both the range of distribution and its concentration, if any, at certain ratios. Low frequency ratios may then be tested on the map for their suitability as isopleths. It is essential to check the positions of the lines on the map, because a graph is like a census table in that it places together data which are geographically separated.

As a general rule, isopleth intervals should be chosen to avoid excessive numbers of isolated "islands" of highs and lows, and should coincide with rapid, rather than gradual, changes in distribution. An isopleth is usually best employed to separate regions of diversity instead of near uniformity.

RELIABILITY OF RATIOS

Since isopleths show ratios and not absolute quantities, identical ratios may differ considerably in their reliability. For example, two townships of the same size could have 10 per cent of their cropland in wheat but if one township had only one farm while the other had one thousand, the reliability of the two 10 per cent ratios would not be comparable. If, however, the isopleth map was accompanied by dot maps showing the distribution of wheat, cropland, and farms, the reader would be able to estimate the reliability of the ratios. An excellent method of supplementing some isopleth maps is to prepare companion maps, such as dot maps, to give the reader a broader background with which to interpret the maps.

SUMMARY AND CONCLUSION

A large variety of quantitative distribution maps are grouped within the general category of isopleth maps. These maps show different kinds of ratios and may be divided into three types upon the basis of their dividends and divisors. Some of the particular problems which arise in isopleth mapping involve the locating of control points, placing of isopleths, selecting the intervals, and reliability of the ratios. These problems are of comparatively little importance in small scale maps with numerous closely spaced control points, but they increase with the scale of the map and the separation of the control points. Since each problem is subject to the variations of individual interpretation, the accuracy, usability, and appearance of many isopleth maps reflect the cartographer's knowledge and appreciation of the special problems and techniques inherent in isopleth mapping.

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SUMMER COTTAGERS IN ONTARIO*

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THE summer cottage has been overlooked as a subject of serious study, in Canada as almost everywhere else. There are no statistics on it, and therefore an accurate appraisal of its importance in the geography and the social and economic life of Canada is not yet possible. The only people interested in summer cottages, apparently, have been their occupants and those who hoped to sell something to them. In order to achieve more intimate contact with their market, the latter have frequently applied to the Canada Post Office for lists of the home addresses of summer cottagers, and from about 1927 to 1941 these were supplied annually, one each for the Maritimes, Quebec, Ontario, and the Western Provinces. During the war years, either the demand for or the supply of canoes, boats, outboard motors, septic toilets, pumping systems, and garden furniture fell off; at any rate not enough mailing lists were sold to make their preparation worth while, and they were discontinued. In 1948 lists were once more prepared. For want of a better source, we must use these post office lists if we wish to gain any idea of the pattern of recreational land use in Canada. In the present paper the Ontario list for 1941 (a census year) has been analyzed.

In its instructions to postmasters, the Canada Post Office stipulated that the names of only those who owned or leased a summer cottage be supplied, and stressed the fact that postmasters were not to copy hotel registers. Thus the intrusion of the names of transient visitors at summer resorts has, we can hope, been kept to a minimum. There are, however, other sources of error: not all summer resorts in Ontario are represented; permanent residents are included (and have, in some cases, offered serious difficulties; *vide* the sections on Hamilton and Toronto in this article); a larger proportion of those far from home may have their mail delivered to the cottage or resort than of those closer to home, but what the exact relation is we cannot say. Thus it is impossible to say how representative a sample of the summer population of Ontario is given by the list, and therefore no authority can be claimed for the analysis that follows. We cannot hope that the results are definitive, but we *can* hope that they are suggestive.

The Pre-eminence of Ontario Among the Provinces in Summer Recreation

Before discussing the summer cottagers in Ontario itself, let us first glance at the relation between Ontario and the other provinces of Canada.

*A statistical table, too unwieldy to be included with this paper, in which the relations between the resort lands of Ontario and the areas supplying cottagers to them are summarized, may be obtained by writing to the author at 100 Walmsley Blvd., Toronto 12, Canada.

In all of Canada there were 61,072 cottagers listed by the Canada Post Office in 1941 (Table I). While Ontario had something less than half the total number, it had over four-fifths of those whose homes were in the United States. the nine provinces in 1941 are shown in Figure 1. ("Urban population" means different things in different provinces, but these are the only figures available.) Each population is expressed as a percentage of the total population for

TABLE I

SUMMER COTTAGERS IN CANADA, 1941

	P.O.[a]	*S.P.O.*[b]	*Canadian*		*American*		*Total*[c]	
			Number	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*
Prince Edward Island	15	0	88	87.1	13	12.9	101	100.0
Nova Scotia	237	1	2,130	81.3	491	18.7	2,623	100.0
New Brunswick	36	2	947	89.0	117	11.0	1,064	100.0
Quebec	526	32	16,185	96.9	515	3.1	16,703	100.0
Ontario	379	113	22,639	80.4	5,520	19.6	28,159	100.0
Manitoba	19	4	3,808	99.8	7	0.2	3,815	100.0
Saskatchewan	25	11	2,979	98.3	53	1.7	3,032	100.0
Alberta	26	4	2,561	99.7	8	0.3	2,569	100.0
British Columbia	44	7	2,927	97.4	78	2.6	3,006	100.0
CANADA	1,307	194	54,264	88.9	6,802	11.1	61,072	100.0

[a] P.O. (Post Office): Post office open all year.
[b] S.P.O. (Summer Post Office): Post office open only during summer months.
[c] Total includes 6 cottagers from outside continental North America.

In Canada as a whole eight out of nine of the cottagers were Canadians, and the rest were Americans. Similar proportions existed in New Brunswick and Prince Edward Island, but in Nova Scotia and Ontario nearly one cottager in five was American. West of Ontario the proportion of Americans was everywhere negligible.

Some indication of the importance of Ontario in the recreational land use pattern of Canada is given by the fact that Ontario had 29 per cent of the post offices reporting (379 out of 1,307), but its share of *summer* post offices, that is, of post offices that serve resorts and are open only during the summer, was twice as great, or 58 per cent (113 out of 194).

Canadian Cottagers

The relations between the Canadian cottagers, the urban population (as given in the Canada Year Book, 1945, page 112), and the total population in Canada. Only in Ontario and Manitoba is the percentage of Canadian cottagers greater than the percentages of both the urban and the total population. In Ontario this is due entirely to the high recreational land use intensity of Toronto discussed later in this paper.

American Cottagers

No detectable relation exists between the shares of Canadian cottagers, American cottagers, and American motorists with long-term permits that each province possesses. The merest glance at Figure 2 shows that Ontario is the most favored destination of American tourists —a fact of no small economic significance. Ontario receives two-thirds of the long-term motorists and *four-fifths* of the tourists that are the most satisfying economically—the summer cottagers. Almost all the other cottagers are shared by Quebec and the Maritimes, each with about one-tenth as many as Ontario.

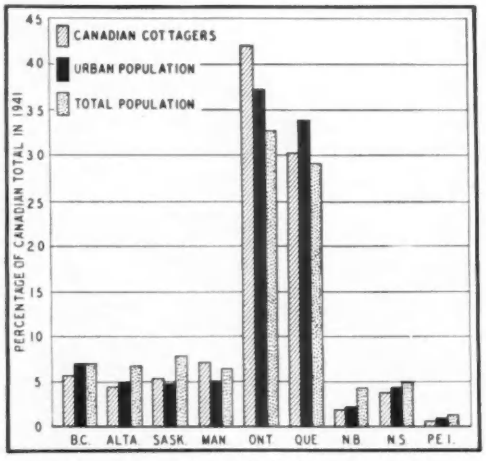

FIG. 1. Proportions of all Canadian cottagers, of total urban population of Canada, and of total Canadian population—in each of the provinces, 1941. (Population data as given in Tables 1 and 22 in Chapter IV, Canada Year Book, 1945.)

It will be instructive to inquire into the reasons for the smallness of Quebec's share of American cottagers as compared with Ontario's share. These reasons are, it would seem, purely geographical. In the northeastern part of the United States, the greatest concentrations of population are in the lowlands along the Atlantic seaboard, the Mohawk valley, the Ohio valley, and on the shores of the lower Great Lakes and the southern part of Lake Michigan. There are five gates into Canada from this populous region: two at the western end of Lake Erie, across the Detroit and St. Clair Rivers; one at the eastern end of Lake Erie, across the Niagara River; one at the eastern end of Lake Ontario, across the St. Lawrence River at the Thousand Islands; and, finally, the corridor up Lake Champlain. Of these gates, the first four lead into Ontario, and only the last leads into Quebec. Moreover, the gates at either end of Lake Erie are in direct contact with the zones of heavy population, and the Thousand-Island gate is close to Rochester and the heavily populated Mohawk valley. But to pass into Quebec by the Champlain gate, the visitor from the heavily populated Atlantic seaboard must pass through one of the most popular resort regions in the United States, for he finds the Adirondack and Catskill Mountains on his left and the Taconic Mountains of New York, the Green Mountains of Vermont, and the White Mountains of New Hampshire on his right. It is for this reason, also, that the representation in Canada of the largest cities in this part of the United States—New York and Philadelphia—is so meager as to be almost nonexistent.

What can Quebec offer, in the way of summer pleasures, that the American visitor cannot find closer to home? An obvious answer to this question might be: "Well, he can find the charms of a foreign country in Quebec—the *habitant*, the oxen, the quaint villages. . . ." Quite true, and for the motor tourist these charms are inviting (in 1941, 225,845 American automobiles entered Quebec on Vehicle Permits, as compared with 757,959 for Ontario; thus, while

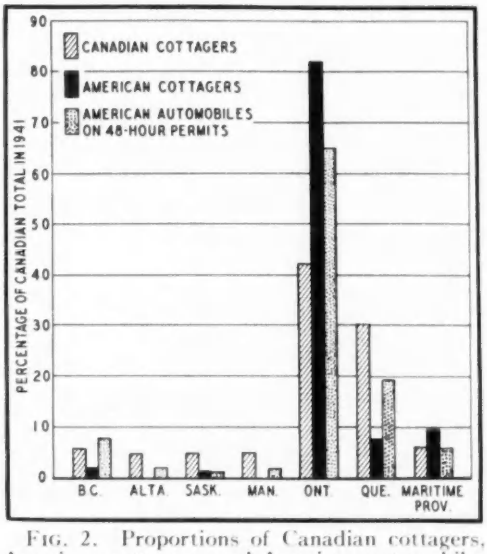

FIG. 2. Proportions of Canadian cottagers, American cottagers, and American automobiles entering Canada on 48-hour permits—in each of the provinces, 1941. (Automobile entries from Table IV, "Canada's International Tourist Trade, 1926–42," Ottawa, 1944.)

there were only one-tenth as many American cottagers listed, there were over one-third as many long-term motorists). But, for the most part, Americans like to have their cottages in the border counties of the Eastern Townships; and, what is more significant, they consort very little with the French, going mainly to those resorts where the English-speaking Canadians predominate.

Thus, comparison with Quebec has shown that Ontario stands pre-eminent among the Canadian provinces as a summer playground for American visitors primarily because of her geographic position.

MAJOR RECREATIONAL DIVISIONS OF ONTARIO AND THEIR USE BY SUMMER COTTAGERS

We may now turn our attention to a detailed study of Ontario itself. The recreational classification of Ontario is listed in Table II. The major divisions are shown in Figure 3 and the complete system of major divisions, regions, and areas in Figure 4. The smallest unit shown is the *resort area*, an arbitrarily named grouping of contiguous summer resorts. Next in size is the *resort region*. The largest unit is the *major recreational division*. The 379 resorts represented in the post office list are grouped into 43 resort areas; the areas into 22 regions; and the regions into 10 major divisions. We have space to discuss only the last of these in detail.

The geological dichotomy that has played such a fundamental part in the social and economic history of Ontario has nowhere been more important than in the development of the recreational land use pattern. Indeed, this dichotomy makes it better to speak not of one pattern but of two, for the differences

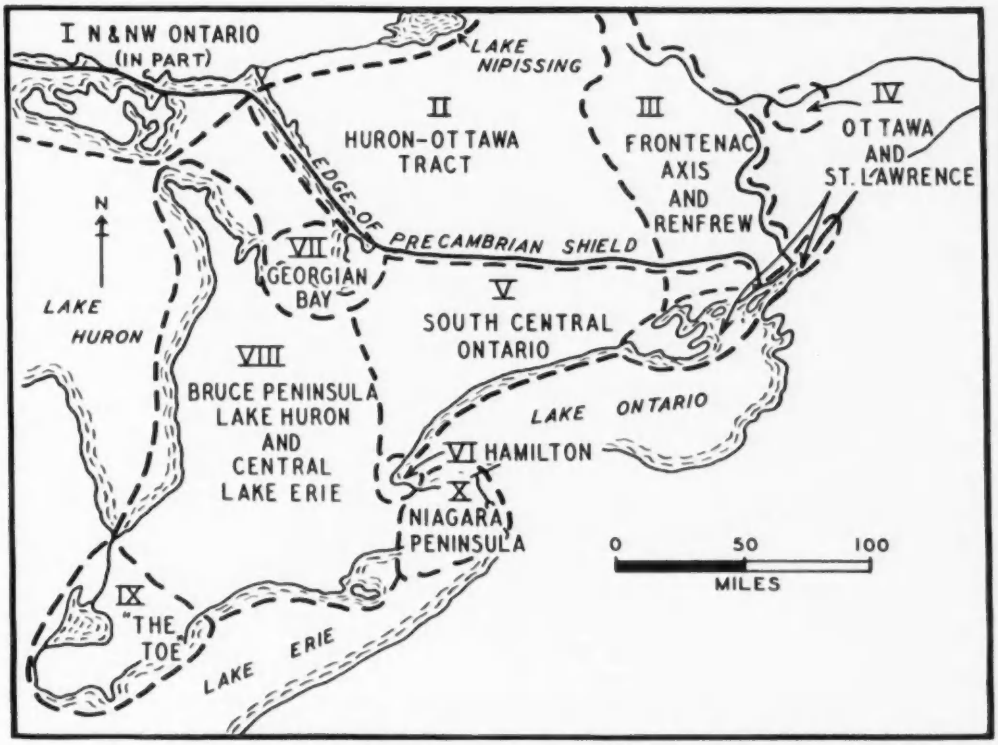

FIG. 3. Recreational land use in Ontario: Major Divisions.

TABLE II

THE RECREATIONAL LANDS OF ONTARIO

Major Recreational Division	*Recreational Region*	*Resort Area*
	Pre-Cambrian Shield	
I. Northern and Northwestern Ontario	A. Northwestern Ontario	1. Lake of the Woods 2. Rainy Lake 3. Quetico Park 4. Head of Lake Superior
	B. North Shore of Lake Huron	5. Sault Ste Marie to Spanish River 6. Spanish River to French River 7. Manitoulin Island[a]
	C. Timagami and Temiskaming	8. Timagami and Temiskaming
	D. French River and Lake Nipissing	9. French River and Lake Nipissing
II. Huron-Ottawa Tract	E. Georgian Bay Islands	10. 30,000 Islands
	F. Mainland near Georgian Bay	11. Parry Sound West 12. Parry Sound East 13. Muskoka Lakes 14. Lake of Bays
	G. Haliburton and Algonquin	15. Haliburton Highlands 16. Algonquin Park
III. East: Frontenac Axis and Renfrew	H. Renfrew	17. Lakeland of Renfrew
	I. Frontenac Axis	18. Rideau Lakes and Land o' Lakes
	Peninsular Ontario	
IV. Ottawa and St. Lawrence	J. Ottawa River	19. Ottawa River
	K. St. Lawrence River and Eastern Lake Ontario	20. St. Lawrence River and Eastern Lake Ontario
V. South-Central Ontario	L. The Lakes, East	21. Trent Canal System, South 22. Rice Lake 23. Kawartha Lakes
	M. Toronto	24. Toronto Island 25. Lake Scugog 26. Lake Ontario, East to Oshawa 27. Lake Ontario, West to Bronte 28. Area within 30-mile radius of Toronto 29. Lake Simcoe 30. Lake Couchiching
VI. Hamilton	N. Hamilton	31. Hamilton or Burlington Beach
VII. Georgian Bay, South	O. Georgian Bay, South	32. Southeastern Georgian Bay: Collingwood to Waubaushene 33. Southwestern Georgian Bay: Owen Sound to Collingwood
VIII. Bruce Peninsula, Lake Huron, and Central Lake Erie	P. Bruce Peninsula	34. Bruce Peninsula
	Q. Lake Huron—the Southern Bay	35. Goderich to Southampton 36. Sarnia to Goderich
	R. Central Lake Erie	37. Central Lake Erie
	S. Southwestern Ontario	38. London-Kitchener Area
IX. "The Toe"	T. Southwest Corner of Ontario	39. St. Clair River 40. Windsor Area 41. Western Lake Erie
X. Niagara Peninsula	U. Eastern Lake Erie	42. Eastern Lake Erie
	V. Niagara R. & L. Ont.	43. Niagara River and Southwestern Shore of Lake Ontario

[a] Geologically, Manitoulin Island is part of Peninsular Ontario; it has been included with the resorts of the Pre-Cambrian Shield because of its geographical position and resulting recreational pattern.

between the recreational areas on the Pre-Cambrian Shield and in Peninsular Ontario are marked.

The Pre-Cambrian Shield is, for the most part, an area of rock, trees, and water. From the air its disorganized drainage presents a wildly pock-marked appearance, and an exceedingly large proportion of the land is riparian to small lakes and streams, and therefore desirable as recreational land. Thus there are many square miles of the Shield where the major form of land use is recreational, and the recreational pattern assumes an *areal* aspect.

Peninsular Ontario, a fertile area bounded on two sides by fresh-water seas and on the third by the Shield, gives no such areal expression to its recreational land. With some exceptions, the most important parts specifically devoted to recreation are the lake shores that form most of the periphery of the area. The major form of land use is agricultural, and rarely does recreational use extend more than one or two hundred yards inland from the lake shores. Here we say that such and such a beach is two miles long, and the recreational pattern assumes, not an areal, but a *linear*, aspect.

The other important respect in which the two parts of Ontario differ is that, to the sparsely populated Shield, cottagers come from a distance, while in Peninsular Ontario the most numerous cottagers are inhabitants of cities and towns close at hand.

Manitoulin Island is geologically and in vegetation part of Peninsular On-

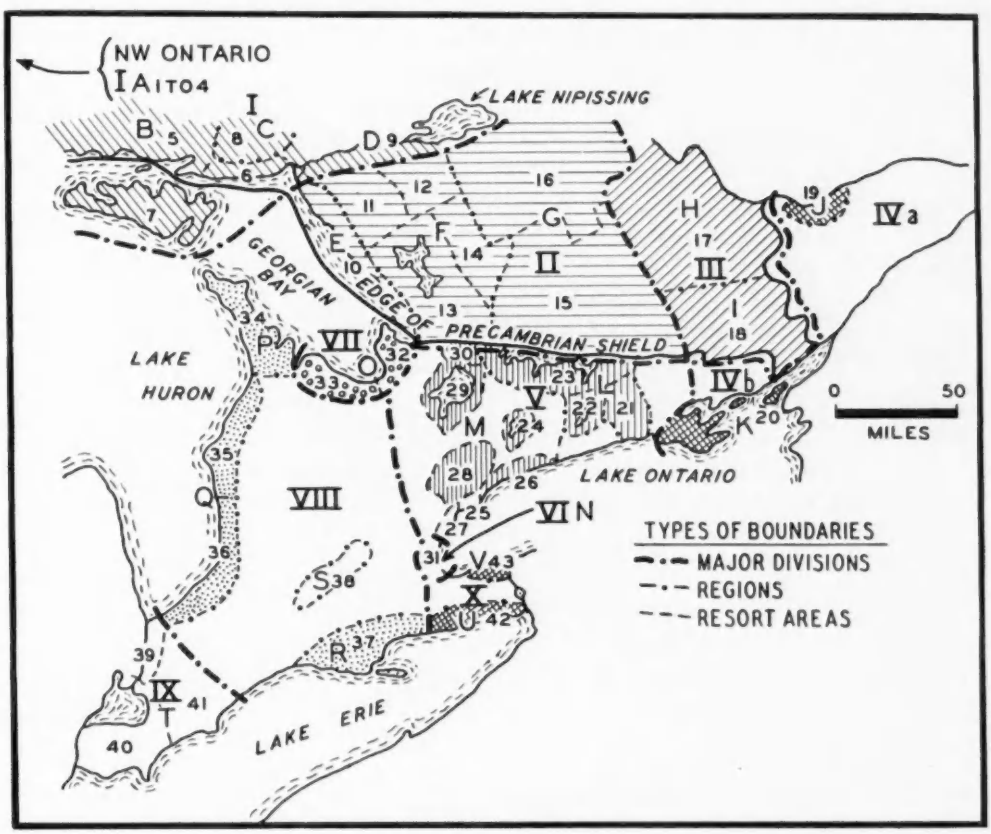

FIG. 4. Recreational land use in Ontario in detail. (For names of divisions, regions, and areas see Figure 3 and Table II.)

tario; because of its remoteness, however, its recreational pattern is closer to that of the Shield, and accordingly it is classed with the latter.

Of the ten Divisions shown in Figure 3 only nine are of sufficient size to deserve the designation "Major." The tenth, that of Hamilton (No. VI on map) embraces only Burlington Beach, the bridge of land that cuts off the westernmost tip of Lake Ontario from the body of the lake. This resort, however, is the only one of any size where cottagers from Hamilton, the second city of Ontario in population, predominate. For this reason it cannot be included in any of the other Divisions, and it has accordingly been assigned to a Division of its own.

Of the 379 post offices that submitted names of cottagers, nearly a third (113) were open only during the summer. The importance of the Huron-Ottawa Tract and South-Central Ontario (Divisions II and V) is evidenced by the fact that together they account for nearly two-thirds of the summer post offices.

Among both Canadians and Americans, in most Divisions, cottage *owners* make up about half the total number. This relation is surprisingly prevalent; nowhere else is it as striking as in the figures for Canadians and Americans as a whole:

	Total Number of Cottagers	*Cottage Owners*	*Ratio (in per cent)*
Canadians	22,639	11,318	50.0
Americans	5,520	2,601	47.1
Both	28,159	13,919	49.5

The most notable departure is among the Americans in the Frontenac Axis, Division III. Americans here are considerably more numerous than Canadians, yet there are little more than half as many owners among them. Among Canadians, only in Division VI, Hamilton, and Division IV, Ottawa and St. Lawrence, in both of which the number of owners is considerably less than half the total, does the relation differ appreciably from the norm.

The places that the cottagers in Ontario come from and the Major Divisions to which they go are shown graphically in Figure 5. Four-fifths of the cottagers are Canadians, almost all of them from Ontario itself. The greatest single source is the city of Toronto, which is the home of two out of every five. The proportion from the second city of Ontario, Hamilton, is little more than one-eighth as great. All of Ontario outside of Toronto and Hamilton contributes just three-quarters as many cottagers as Toronto alone.

One-fifth of the Ontario cottagers come from the United States, the bulk of them from the four states that border on the Lower Lakes. The reason for the preponderance of New York, Michigan, Ohio, and Pennsylvania (in that order) needs no discussion.

The pie diagram on the right in Figure 5 shows that one-half of the cottagers in Ontario are to be found in Central Ontario (South-Central and Hamilton) and the Huron-Ottawa Tract. The area occupied by these Divisions has its base on Lake Ontario, and extends northward along the main traffic artery, King's Highway No. 11, to Lake Simcoe (see Fig. 4). On Lake Couchiching, the northward extension of Lake Simcoe, the edge of the Shield is struck. Thenceforward, the western limit of the area is Georgian Bay. The northern limit is at the French River and Lake Nipissing. The eastern limit is everywhere indeterminate, losing itself, in its northerly parts, in the highlands of Haliburton and the Lakes of Algonquin Provincial Park.

Next in importance is the area I have called Major Division VIII. This

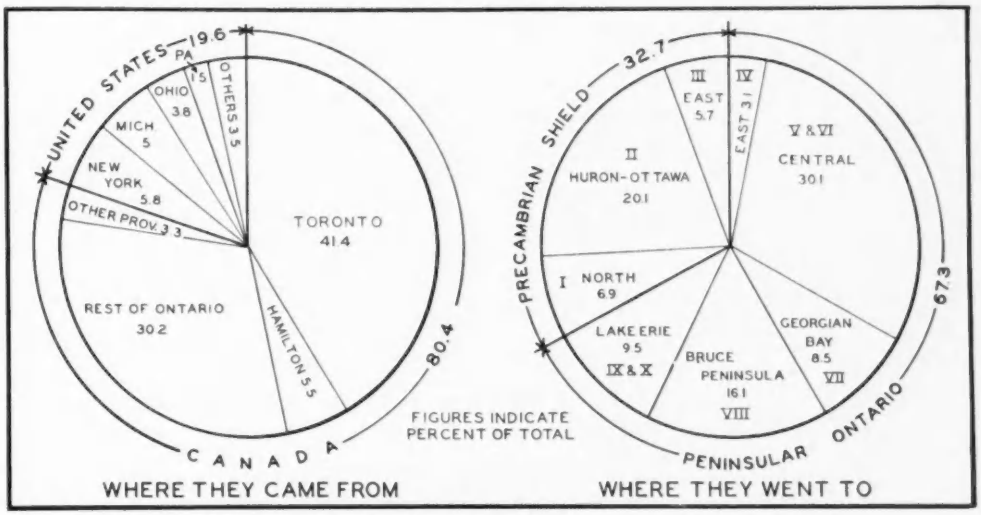

FIG. 5. Sources and destinations of the 28,000 cottagers in Ontario in 1941.

Division is all periphery and no core (see Fig. 3). In it are included the extensive shoreline of the Bruce or Saugeen Peninsula, the southeastern shore of Lake Huron, and the central segment of the north shore of Lake Erie. Here are found one-sixth of the cottagers in Ontario.

The remaining six Divisions share one-third of the cottagers between them.

Major Division I: Northern and Northwestern Ontario

The northern part of the province is not shown on the map (Figs. 3 and 4) because its recreational importance is not sufficient to justify the reduction in scale necessary to include it. This part of the province is too far removed from important centers of population to have large numbers of cottagers. It is a land for fishermen and hunters, rather than for families that come to spend the summer. There are a few cottagers listed in Timagami, Temiskaming, Algoma, and at the head of Lake Superior. (Unlisted is the phenomenal development at Ferris, a suburb of North Bay, on Lake Nipissing. This is one of the largest suburban resorts in the province. Were it listed, the pattern for northern Ontario would be substantially different from that here presented.) More important than any other section of Division I is the westernmost corner of Ontario, where it borders on Manitoba and Minnesota. Here, on Lake of the Woods, is the only area where cottagers from another province are of importance. This is, to a surprising extent, a summer dormitory of Winnipeg, Manitoba, 125 miles to the west. Three-quarters of the cottagers from other provinces in the whole of Ontario are found here, and nearly all are from Winnipeg. (The remaining quarter come mainly from Montreal, and are widely dispersed throughout the eastern and central parts of Ontario, so that they are nowhere of any importance.) Finally, Winnipegers are the largest single element in northern and northwestern Ontario, accounting for 38.7 per cent of the cottagers there. Americans account for 30.0 per cent. Only one cottager in four comes from Ontario itself: there are few towns in this part of the province.

Major Division II: The Huron-Ottawa Tract

To the Huron-Ottawa Tract (or Ottawa-Huron Tract, its historically more accurate name) come:

20 per cent of all cottagers in Ontario;

20 per cent of American cottagers in Ontario;

20 per cent of the cottagers from New York State in Ontario.

Furthermore, of all the cottagers in the Division, 20 per cent are American.

The Huron-Ottawa Tract is remote from the American border and consequently from the four states that are mportant in the recreational pattern in Ontario. It is most remote from Michigan, and we find that only 6 per cent of the Michiganders in Ontario are to be found here. While there are fewer cottagers from Pennsylvania than from Ohio or New York, their number constitutes more than one-third of all the Pennsylvanians having cottages in Ontario.

Four out of five of the cottagers are Canadians, and there are more than twice as many from Toronto as from the rest of Ontario. Toronto thus supplies more than half the cottagers on the Tract.

Major Division III: Frontenac Axis and Renfrew

In eastern Ontario a prong of the Pre-Cambrian Shield, the Frontenac Axis, cutting off the triangle formed by the confluence of the Ottawa and St. Lawrence Rivers from the rest of Peninsular Ontario, passes southward into the United States via the Thousand Islands, and brings the characteristic Shield topography closer to American vacationers than at any other point. This eastern segment of the Shield is far less important recreationally than the western (that is, the segment included

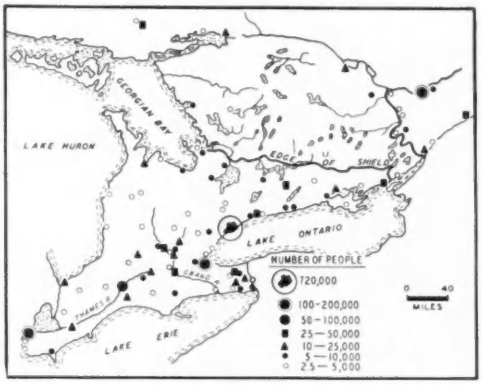

FIG. 6. Urban centers with populations of 2500 and over in Ontario.

in Division II). It has little more than one-quarter the number of cottagers, and accounts for less than 6 per cent of the total in Ontario. This difference is due almost entirely to the decrease in the number of *Canadians*, for, owing to its accessibility to the United States, Americans are almost as numerous as in the Division to the west. The smaller number of Canadian cottagers is attributable to the fact that this region is more than 200 miles distant from Toronto and the populous southwestern part of Ontario (see Fig. 6). For this reason the role of Americans is emphasized, and they contribute three out of five cottagers in the Division. Only in the Niagara Peninsula is the proportion of Americans to the whole greater.

Summary: The Pre-Cambrian Shield, Divisions I–III

To summarize, on the Pre-Cambrian Shield as a whole are to be found one-third of all the cottagers, and nearly one-half of all the American cottagers, in Ontario. Since almost all the cottagers must come from a distance, the popularity of the Shield as a resort country is testimony to its desirable recreational attributes. Indeed, if the incidence of summer hotels in Ontario were added to

our survey, the importance of the Shield as a recreational resource would be even more apparent, for there are more of these in the Muskoka Lakes district alone than in all of Peninsular Ontario. Two hundred years ago the Shield was used mainly as a source of fur-bearing animals; 100 years ago its main importance was as a source of timber; 50 years ago began the mining development of the Shield; and today it is becoming immediately important to more people as a recreational wilderness area than in any other way. A similar, though not completely parallel, development has taken place in certain parts of the State of New York, in the cut-over lands of Michigan, and in the lakelands of Wisconsin and Minnesota.

Division IV: Ottawa and St. Lawrence

In the eastern part of Peninsular Ontario, cut off from the rest by the Frontenac Axis, there are not more than 877 cottagers listed all told. Of these, only 68, or 7.8 per cent, are Americans, over half of them from New York State. Only up-state New York is represented. There are 55 Canadians from outside Ontario, chiefly from Montreal. As might be expected, the majority of the cottagers come from cities and towns of eastern Ontario. Only one in six comes from Toronto.

Division V: South-Central Ontario

There are more cottagers listed in South-Central Ontario than in any other part of the province, because it is the immediate recreational hinterland of the city of Toronto, second largest in Canada, and because it is the only part of Peninsular Ontario well endowed with inland lakes. (Indeed, so well endowed are parts of it, in this respect, that their recreational land use patterns seem to have, in Figure 4, an areal aspect comparable to that of the Shield, instead of the linear aspect proper to Peninsular Ontario. The major form of land use throughout is, however, agricultural, and these resort regions owe their anomalous appearance to the smallness of scale of the map.) Of the inland waterways of Division V the most important is Lake Simcoe (Resort Area 29 in Fig. 4). Next are the Kawarthas (23), a remarkable string of lakes that skirt the edge of the Shield and owe their existence to it; Lake Scugog (24) and Rice Lake (22); and the streams and ponds that gain recreational significance by virtue of being in the immediate vicinity of Toronto (28). Added to these is the shore of Lake Ontario: to the west of Toronto (27); to the east (26); and within the city itself, in the form of a striking sand spit known as Toronto Island (25).

Toronto supplies over three-quarters of the cottagers to be found in this Division, and there are more Torontonians to be found here than in all the rest of Ontario. Most of the remaining cottagers are from cities and towns near each resort.

Of the nearly 8000 cottagers listed here, fewer than 500 are American; only one American in twelve comes to this Division.

Division VI: Hamilton

As has been said, the only reason for constituting Hamilton a Major Recreational Division is that here only, at Burlington Beach, is there a sizable resort where citizens from the second city of Ontario predominate: of 571 cottagers listed, 556 come from Hamilton.

Toronto has a similar civic resort, if we may so call it, in Toronto Island, on which 354 cottagers are listed. There is a notable difference between the lists for the two cities: the home addresses of *all* the cottagers on Toronto Island

are on the mainland, but half of those at Hamilton (275 out of 556) are on the Beach itself. It would perhaps be preferable to class the latter as suburban residents of Hamilton, rather than as cottagers; to do so, however, would be to edit the Post Office lists, and this I have refrained from doing.

Division VII: Georgian Bay

Apart from Hamilton, there is no Recreational Division where so few Americans are listed as on Georgian Bay South. In all, there are only 97 of them, constituting 4.1 per cent of the cottagers there, and less than 2 per cent of Americans in Ontario. The reason may be that this area is so close to the most desirable part of the Shield, and particularly to the 30,000 islands of Georgian Bay, the fragmented edge of the Shield, that Americans who have already come a considerable distance feel that they might just as well go a little farther to reach the more desirable spots. Toronto is also a considerable distance from this area, but Torontonians find it more attractive than their own Lake Ontario; while nearly 1500 of them are listed on Georgian Bay South, there are little more than two-thirds that number on the whole of Lake Ontario. They make up over 60 per cent of the total, and all the rest come from near-by towns and from the agricultural-industrial complex of southwestern Ontario of which the towns on the Grand River are the heart (Fig. 6).

Division VIII: Bruce Peninsula, Lake Huron and Central Lake Erie

Reference to Figure 6 shows that the greatest concentration of urban centers in Ontario is in a belt stretching westward from the end of Lake Ontario for two-thirds of the distance along Lake Erie, with a bulge toward the northwest along the Grand River. Division VIII—the Bruce Peninsula, Lake Huron and Central Lake Erie—is the recreational hinterland of this highly urbanized area. Of the 4550 cottagers listed, only 53 are on the two small inland lakes shown as Resort Area 38 (Fig. 4); the rest are on the periphery. Georgian Bay South (Division VII) might with justice have been linked with this area. The reason it was not is that Georgian Bay is primarily a summer dormitory of Toronto, while Torontonians make up only one-eighth of the number of cottagers in Division VIII. In the latter, nearly two-thirds come from the urbanized, non-recreational core.

Close to the cities in the core, land of recreational value is largely non-existent, or has been destroyed by incorrect usage; here, as nowhere else in Ontario, the recreational drive, the drive towards bodies of water that may be used for play, is centrifugal. Toward the east the drive is counterbalanced by the pressure of escaping Torontonians; thus people from the core do not frequent Lake Ontario, which, moreover, is uninviting because of its coldness. Similarly, they make up less than a tenth of the summer population of Lake Simcoe. They begin to make themselves felt on Georgian Bay, where they constitute nearly 30 per cent of the summer population. But it is in Division VIII, their own hinterland, that people from the core come into their own; here they occupy two cottages out of three.

It is because of the importance of the people from this part of Ontario in each, that the beaches of the Bruce Peninsula, Lake Huron, and central Lake Erie have been grouped together as one Division. In all of these places they constitute over half the summer population. Nowhere else do they approach this degree of importance.

Americans are more numerous here

than in any other Division in Peninsular Ontario except "The Toe" (Division IX). More than 10 per cent of the Americans in Ontario are found here. While the 645 Americans, however, constitute only one-seventh of the total number of cottagers in the Division, the 518 Americans in the Niagara Peninsula constitute nearly two-thirds of all the cottagers there. Thus, a few more Americans in Division VIII are interspersed among a great many more Canadians. More than half are from Michigan, mostly spread out along Lake Huron from Sarnia to the tip of the Bruce Peninsula. The remainder are mainly from New York State and Ohio; there are only 18 Pennsylvanians listed.

Division IX: "The Toe"; and Division X: Niagara Peninsula

Divisions IX and X are considered at the same time because each is essentially a summer dormitory of an American city.

Every part of Division IX, "The Toe," can be reached from Detroit by motor within an hour or two; much of it is but a few minutes away, across the Detroit River. Detroit has the greatest concentration of population—with, at the same time, wealthy suburbs such as Grosse Point and Highland Park—with access to this Recreational Division. It is not surprising, therefore, to find that 41.4 per cent of the cottagers listed in "The Toe" come from Detroit. At the same time, of all the people from Detroit with cottages in Ontario, two out of three are to be found in "The Toe." The reason that Detroit does not make an even bigger showing, proportionately, is that the Division itself contains sizable towns, which together supply a number of cottagers almost exactly equal to that from Detroit. Michigan and Ontario each supplies over 45 per cent of the cottagers; almost all the remainder come from Ohio.

Buffalo plays an even more important part in the Niagara Peninsula than Detroit does in "The Toe," supplying more than one-half of the cottagers there. Most of the remainder come from the cities and towns of the Peninsula. Of the Buffalonians in Ontario, three out of five go no farther than the Peninsula, and most of them are to be found at Crystal Beach, on Lake Erie, only a few minutes away. So much is Ontario's Crystal Beach an adjunct of Buffalo that the contest for the Miss New York State of 1949, sponsored by a Buffalo radio station, was held there; and Lillian Ross, in her article on the Miss America Pageant ("Symbol of All We Possess," *New Yorker*, October 22, 1949, p. 36) does not even tell us that it is in Canada.

Two of the oldest resorts in the province, which were among the most fashionable at the turn of the century, are Grimsby Beach, on Lake Ontario, and Niagara-on-the-Lake, at the mouth of the Niagara River. Toronto newspapers of the 1900's published long lists of the prominent people who attended each of these resorts. But their popularity has waned. Today the number of Torontonians in the Peninsula is little larger than that in the remote area at "The Toe" of the province. The Niagara Falls are the greatest tourist attraction in Ontario's possession. But they are an attraction to be visited and admired for a day, not to be lived with for the summer. There is nothing else to induce people to come from afar to summer in the Niagara Peninsula.

AMERICAN COTTAGERS IN ONTARIO

The proportions of Canadian and American cottagers in each of the ten Major Recreational Divisions of Ontario are shown in Figure 7. Ameri-

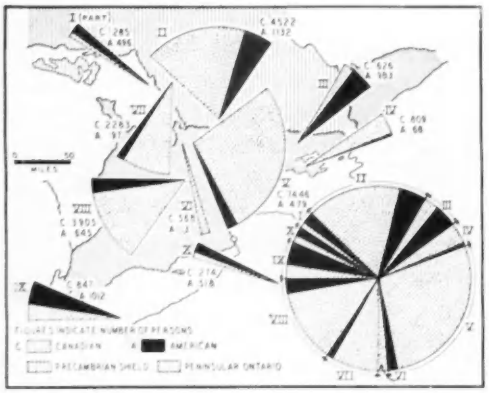

FIG. 7. Distribution of Canadian and American cottagers in the Major Recreational Divisions of Ontario. Roman numerals refer to Major Divisions as shown in Figures 3 and 4 and Table II. The graph at the lower right sums up the story for the 21,565 Canadian and 5,433 American cottagers in Ontario.

cans preponderate in III, IX, X, and in the part of I that is least remote from Peninsular Ontario. While there are more Americans in II than in any other Division, they are outnumbered by Torontonians. In V they are again outnumbered by Torontonians; in IV, by people from urban centers in eastern Ontario; and in VII and VIII by people from the urban complex in southwestern Ontario. Division VI, we have found, draws few cottagers, either Canadian or American, from outside the city of Hamilton.

The summer dormitories that are primarily American are of two kinds: those in Peninsular Ontario that are located on or near the American border and draw their inhabitants from the neighboring American cities, Detroit and Buffalo (IX and X respectively); and those on the Shield that are remote from Canadian concentrations of population (I and III). The pulling forces are quite different: Americans come to resorts in Peninsular Ontario only when they are nearby; resorts on the Shield draw Americans because, in spite of their remoteness, they are desirable places for recreation.

The Lower Lakes States

The importance of the four Lower Lakes States—Michigan, Ohio, Pennsylvania and New York—as sources of cottagers in Ontario is illustrated in Figure 8. Only one American out of five in Ontario comes from outside the four states. While the representation from the State of New York is greater than that from any other, the most important city is Detroit, in Michigan. Of all Americans, Ohioans are the most ubiquitous and Pennsylvanians the most clannish. (The reason for the use of this last word will appear below.)

The cottagers from each state distribute themselves in a pattern characteristic of that state, one that is largely determined by the geographical relations between it and Ontario.

Michigan.—Most of the cottagers from Michigan are from Detroit, and in Ontario they remain close to the Michigan border. Well over half are found in "The Toe," and almost all the remainder on the shore of Lake Huron (Division VIII). Very few find their way to the Shield. The most important attribute that the Michigander looks for in a Canadian resort, apparently, is propinquity. He has his own Shield-like lakeland in the cut-over lands in the northern part of his own state, and does not need to travel the hundreds of miles to the Shield of Ontario to reach the wilderness.

Ohio.—The number of cottagers from Ohio is similar to that from Michigan, but in every other respect there is a striking contrast between the two states. To Ontario, Michigan is Detroit, but Ohio is not only Cleveland, the most important city, but Columbus, Youngstown, Cincinnati, and numerous small towns as well. Similarly, to Michigan, Ontario is Lake Huron and the western

end of Lake Erie; Ohioans, on the other hand, are to be found everywhere except in the Niagara Peninsula, in the easternmost corner of the province, and, of course, in Hamilton. In this ubiquity is reflected the position of Ohio on Lake Erie. Nowhere is there contiguity with Ontario; to enter it, Ohioans must drive west or east along Lake Erie, or cross it by boat, and thus they are not channelled towards any one spot. That they are found in such numbers as far east as the Frontenac Axis is surprising. More than half go to the Shield, in keeping with the generalization that Americans who have to travel some distance to enter Ontario are more likely to continue on to the Shield than to remain in the less desirable resorts of Peninsular Ontario.

New York and Pennsylvania.—The generalization just mentioned is illustrated admirably by the travellers from New York and Pennsylvania; they are accordingly considered at the same time, in spite of the fact that New York sends the largest and Pennsylvania the smallest contingent of any of the Lower Lakes States to Ontario recreation lands.

Both states lie south of the whole of Lake Ontario; this accounts for their similarities. While New York is separated from Ontario only by a river at either end of the lake, Pennsylvania has no points of contact; this accounts for their differences. To discuss the latter first, Pennsylvania has no city comparable to Detroit, lying just across a narrow river from Ontario. In Buffalo, New York has such a city. Thus, Buffalo is to the eastern end of Lake Erie what Detroit is to the western, and relatively few Buffalonians stray far from the Canadian resorts in the immediate vicinity of their city. Of those that do, almost all go to the

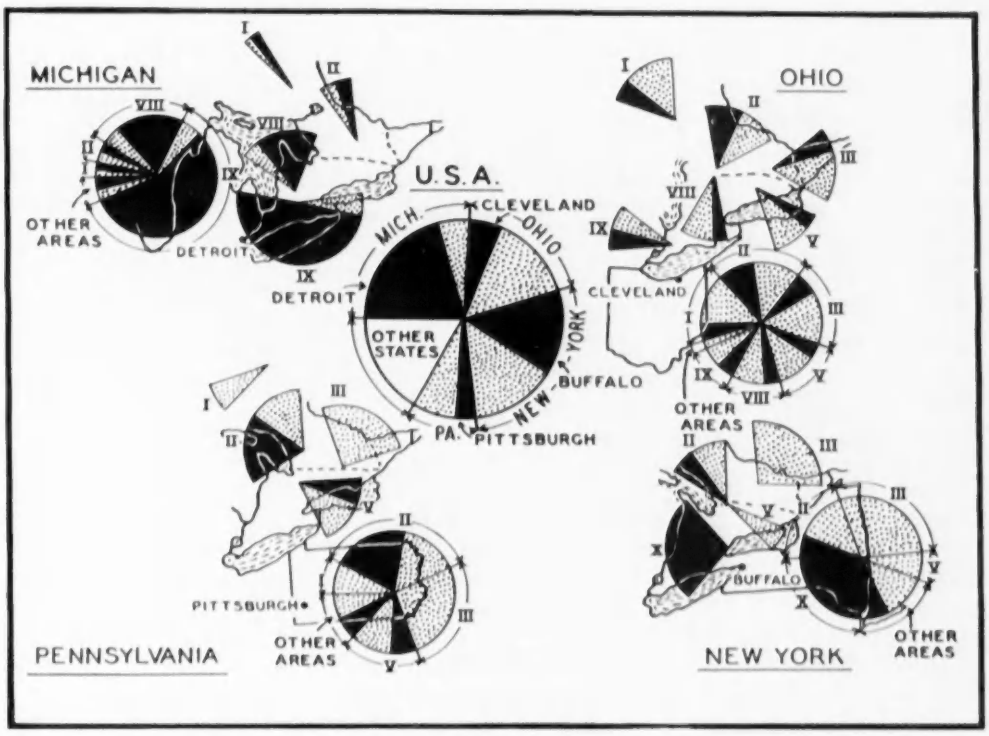

FIG. 8. Distribution of cottagers in Ontario from the four Lower Lakes States.

western part of the Huron-Ottawa Tract. Similarly, fewer Pennsylvanians than New Yorkers enter Ontario because the former have to travel farther than the latter to get there.

The states are similar in that in both, the city of major importance as a source of cottagers to Ontario—Buffalo in New York and Pittsburgh in Pennsylvania—is in the western part of the state, while most of the smaller urban centers that send cottagers are to the east. Thus, the path into Ontario from both Buffalo and Pittsburgh is across the Niagara River; the path from the towns and cities of the eastern part of each state is across the St. Lawrence. The resulting distribution is seen in Figure 8: There are more cottagers from Pittsburgh in Division II, due north of the Niagara River, than in any other Division; and, as we have seen, most Buffalonians simply cross the Niagara River to live in resorts on eastern Lake Erie. Division III, which touches on the St. Lawrence, is the major destination of New Yorkers from outside Buffalo and Pennsylvanians from outside of Pittsburgh. One-third of the New Yorkers come from Rochester and the rest from towns and cities of up-state New York. Where the Pennsylvanians come from is illustrated in the breakdown of the figures for Chaffey's Locks, in the Frontenac Axis, given in Table III. Here it is seen that only six towns, of the 22 represented, are in the western part of the state, contributing only nine of the 46 Pennsylvanian cottagers. These figures may be contrasted with those of the nine post offices in Division II reporting over ten Pennsylvanian cottagers each (Table III). Here Pittsburgh alone supplies half the number, while the eight eastern towns (out of a total of 28) supply only nine cottagers out of 99. The figures for Beaumaris, in the Muskoka Lakes district, are even more striking:

Total number of cottagers	86
American cottagers	41
Cottagers from Pennsylvania	31
Cottagers from Pittsburgh	26

There are very few cottagers from the cities of New York and Philadelphia, the largest in the two states. The reason for this is to be looked for in the geomorphology of the country that lies between these two cities and Canada, as mentioned in an earlier section.

The characteristic of the Pennsylvania pattern that I have called "clannishness" may or may not be significant. Many individual Ontario resorts have noticeable concentrations of cottagers from certain small Pennsylvania towns. Thus Barry's Bay and Combermere have people from Oil City; Wigwassan, people from the town of Indiana; Chaffey's Locks, from Brackney; Footes Bay, from Washington; Port Carling and Magnetawan, people from Sewickley. Comparable examples for other states are much less numerous; Ohio has one such in Washington Court

TABLE III

SOURCES OF PENNSYLVANIANS

At Chaffey's Locks, Division III		*At 9 Resorts in Division II with More than 10 Each*	
From Pittsburgh	3	From Pittsburgh	50
From 5 other western towns	6	From 17 other western towns	28
From 5 central towns	10	From 2 central towns	12
From 11 eastern towns	27	From 8 eastern towns	9
Total	46	Total	99

House, the home of a number of cottagers in Cedar Nook, and New York has a surprising one in Wellsville, for this south*western* New York town is the home of a number of cottagers at Perth Road, which is in the *eastern* part of Ontario. That fellow townsmen will congregate in a given resort is to be expected, but why people from Pennsylvania towns should be more prone to do so than others is not clear.

TORONTO AND THE SUMMER COTTAGERS OF ONTARIO

Citizens of Toronto are the most important single element in the recreational pattern of Ontario. We shall now examine their distribution in detail.

Relations between Toronto, Hamilton, and the Rest of Ontario

The city of Toronto contained, in 1941, little more than one-sixth the population of Ontario, yet it was the home of more than half the Ontario cottagers (see Table IV). In Toronto there was one cottager listed per 57.4 population; in Ontario, outside of Toronto, there was one per 312. Thus we might be led to the conclusion that, per unit of population, there were nearly six times as many cottagers from Toronto as there were from the rest of the province. Yet this conclusion would be scarcely meaningful, for many people list themselves, at summer resorts, as Torontonians, who do not live within the city at all, but in the suburbs; further, summer cottagers are almost exclusively urban dwellers, and this fact must be taken into account in our analysis.

We are faced with the necessity of making certain arbitrary assumptions. I propose to choose sets of figures that are least likely to overemphasize the importance of Toronto in the recreational pattern of Ontario. Included with the population of the city of Toronto will be those of its seven incorporated and five unincorporated suburbs, so that the figure is raised from 667,457 to 902,946. (The population of the unincorporated suburbs is obtained from a source different from that of the others, but this need not affect our results.) Since it appears, from an examination of the post office lists, that towns of fewer than 8000 inhabitants are the homes of but an insignificant number of cottagers, I propose that, for the purposes of the present section, we assume that *all* cottagers come from the towns of 8000 and over, to which we shall give the name of "Urban Ontario." The role that Toronto plays in the recreational pattern remains impressive.

In order that we gain a clearer idea of Toronto's relation to the rest of the province, let us speak of an "Index of Recreational Land Use Intensity." This

TABLE IV

RELATIONS BETWEEN CITY OF TORONTO AND THE REST OF ONTARIO, IN POPULATION AND IN NUMBERS OF HOME ADDRESSES OF COTTAGERS

	Population[a] (1)	*Number of Home Addresses of Cottagers Listed* (2)	*Ratio (1/2)* (3)
City of Toronto	667,457	11,626	57.4
Rest of Ontario	3,120,198	10,012	312.0
ONTARIO	3,787,655	21,638	174.9

[a] From Canada Year Book, 1945, Ch. IV, Tables 1 and 25.

term is equivocal, for it hints at a scientific exactitude that it does not have. It is nonetheless useful in giving us a tool for comparing the extent to which the people of two cities indulge in the custom of going to the cottage during the summer.

A fault of these figures is that the populations of Toronto and Hamilton are included *within* that of urban Ontario, and therefore we cannot get a proper idea of the relations of the cities to the *rest* of Ontario. This fault is remedied in Table VI, which, because

TABLE V

INTENSITY OF RECREATIONAL LAND USE OF GREATER TORONTO AND GREATER HAMILTON AS COMPARED WITH "URBAN ONTARIO" AS A WHOLE

	Population[a] (1)	*Percentage of Population of "Urban Ontario"*[b] *(2,180,863)* (2)	*Number of Homes of Cottagers Listed* (3)	*Percentage of Cottagers from "Urban Ontario"*[b] *(21,638)* (4)	*Index of Recreational Land Use Intensity (4/2)* (5)
Greater Toronto[c]	902,946	41.3	11,626	53.6	1.30
Greater Hamilton[d]	182,566	8.4	1,530	7.1	0.85
Greater Hamilton	182,566	8.4	1,255[e]	5.8	0.69

[a] From Canada Year Book, 1945, Ch. IV, Table 25; and Annual Report of Municipal Statistics for Ontario, 1941.
[b] "Urban Ontario" includes the cities and towns with population of 8000 and over, plus their incorporated and unincorporated suburbs.
[c] Population of Greater Toronto:

City of Toronto	667,457
Seven incorporated suburbs	53,414
Five unincorporated suburbs	182,075
	902,946

[d] Population of Greater Hamilton:

City of Hamilton	166,337
Dundas and Burlington	9,091
Saltfleet Township	7,138
	182,566

[e] 275 permanent residents of Burlington Beach omitted.

If a given city, let us say, has 10 per cent of the population of the province, and if at the same time it supplies 10 per cent of its indigenous cottagers, then we can say that it supplies exactly the same number of cottagers, in proportion to its population, as the province as a whole. In a word, its Index of Recreational Land Use Intensity is 1.00. Should it supply 20 per cent of the indigenous cottagers, then its Index would be 2.00. In Table V are shown the Indices of Recreational Land Use Intensity of Toronto and Hamilton. Toronto's Index is 1.30 and Hamilton's is 0.85, and thus the intensity of use by Torontonians is shown to be much greater than that by Hamiltonians.

the figures for Toronto and Hamilton have been removed from those for Ontario, gives us a better idea of these relations. To distinguish this Index from the previous one, we may call it the "Index of *Relative* Recreational Land Use Intensity," the intensity of all the rest of urban Ontario, exclusive of Toronto and Hamilton, being taken as 1. Now the Index for Toronto is 1.67, or two-thirds greater than that for "the rest of Ontario," and that for Hamilton is 1.08.

Comparison of the Indices for Hamilton in the two tables is instructive. While the Index for Hamilton is lower than that for urban Ontario as a whole, it is slightly greater than that for the

TABLE VI

INTENSITY OF RECREATIONAL LAND USE OF GREATER TORONTO AND GREATER HAMILTON AS COMPARED WITH THE REST OF "URBAN ONTARIO" OUTSIDE THESE TWO CITIES

	Population[a] (1)	*Percentage of Population of Rest of "Urban Ontario"*[b] *(1,095,353)* (2)	*Number of Homes of Cottagers Listed* (3)	*Percentage of Cottagers of Rest of "Urban Ontario"*[b] *(8,482 or 8,207*[e]*)* (4)	*Index of Relative Recreational Land Use Intensity (4/2)* (5)
Greater Toronto[c]	902,946	82.2	11,626	137.2	1.67
Greater Hamilton[d]	182,566	16.7	1,530	18.1	1.08
Greater Hamilton[d]	182,566	16.7	1,255	15.3[e]	0.92

Notes [a], [b], [c], [d], and [e] same as for Table V.

part of urban Ontario outside of Hamilton and Toronto. In other words, the intensity of recreational land use by Hamiltonians is considerably less than that by Torontonians, to be sure, but it is on a par with that of the rest of the province. (It will be remembered that there are 275 permanent residents of Hamilton Beach who could be classed as suburbanites, rather than as cottagers. If this were done, the relative intensity of Hamilton would sink to 0.92, which would mean that towns much smaller than Hamilton had, in the aggregate, a higher intensity of recreational land use—quite the reverse of what one would expect.)

To find an explanation for the greater number of cottagers per unit of population from Toronto, as compared with Hamilton, we must enquire into the economic status of the populations of the two cities. Hamilton is primarily an industrial city, while Toronto is industrial and commercial as well. The relations between Toronto and Hamilton in several respects are given in Table VII. Toronto had, in 1941, something less than five times the population of Hamilton, and there was a similar ratio in the total numbers of male workers. But Toronto had over seven and one-half times as many people occupied as managers, in commerce, in finance and in the professions; in numbers of cottagers the ratio was strikingly similar. It would appear that the number of cottagers from a city depends only indirectly upon its size, the direct dependence being on the number of its well-to-do families. Toronto is not only the largest city in Ontario, but its

TABLE VII

RELATIONS BETWEEN TORONTO AND HAMILTON IN VARIOUS RESPECTS, 1941

	Toronto	*Hamilton*	*Ratio*
Population of greater city	902,946	182,566	4.94:1
Automobile registrations[a]	134,580	28,183	4.78:1
Number of male gainfully occupied[b]	228,706	47,338	4.84:1
Total earnings of above[b]	$292,500,000	$58,250,000	5.02:1
Number employed in managerial, financial, commercial and professional occupations[b]	21,729	2,789	7.79:1
Earnings of above[b]	$57,657,000	$7,330,000	7.88:1
Number of homes of cottagers listed	11,626	1,530	7.61:1

(If the 275 permanent residents of Hamilton Beach are omitted, the ratio becomes 9.28:1)

[a] Motor Vehicles Branch, Ontario Dept. of Highways, personal communication.

[b] Compiled from data in Census of Canada, 1941, Tables 7 and 8.

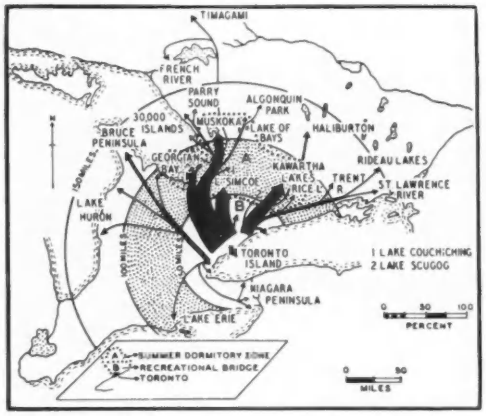

FIG. 9. The summer dormitories of Toronto.

commercial and financial heart as well. This accounts for the high level of income of much of its population, and therefore for the high intensity of recreational land use.

The Summer Dormitories of Toronto

The relations between Toronto and the Resort Areas of Ontario are shown in Figure 9. There are 43 Resort Areas in Ontario (Table II), of which 22 are named on the map. This figure shows that the movement of summer population out of Toronto is essentially northward. The four major summer dormitories of Toronto, in the order of their importance are: Lakes Simcoe and Couchiching, the Muskoka Lakes, Georgian Bay, and the Kawartha Lakes. They are removed from the city by a belt some 50 miles wide, and the dormitories themselves extend to the north and northeast for another 70 miles. In ecological terms, we have added segments of two zones to the city of Toronto: a buffer zone 50 miles wide, a recreational bridge, to cross which is part of the fun of summering in the country; and a summer dormitory zone 70 miles wide.

Undoubtedly the occurrence of the summer dormitory zone is universal among American cities, but the buffer zone is likely to occur much less frequently. Toronto has a buffer zone because Lake Ontario, on which it stands, is so cold as to be uninviting to vacationers, so that Torontonians are tempted to search for other vacation lands; at the same time the immediate hinterland is prevailingly agricultural. But there is a network of fine roads to the desirable lakelands beyond, and among its nearly a million inhabitants, metropolitan Toronto has a large proportion of people with comfortable means, who can afford the motor cars and the time to travel across the recreational bridge to the summer dormitory. It is noticeable that the farther limit of the dormitory zone, some 120 miles from Toronto, is a comfortable day's drive away; the lands beyond are, if anything, more desirable than those in the dormitory itself, but roads are fewer and they are beyond the optimum range of the automobile.

How important cottagers from Toronto are in the recreational pattern of each of the Resort Areas of Ontario can be seen in Figure 10. In Toronto itself, on the Island, the cottagers are all Torontonians. The shape of the

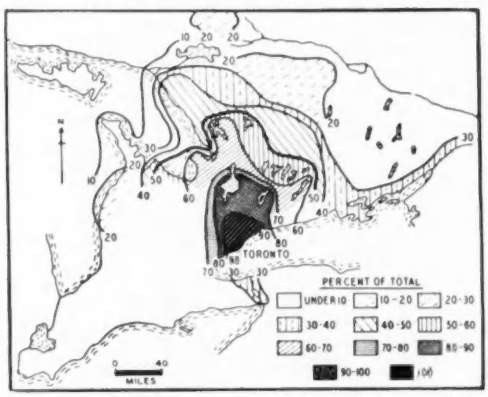

FIG. 10. Proportion of cottagers from Toronto in summer resort regions of Ontario. Near Toronto, naturally, the proportion approaches 100 per cent, but even at Lake Simcoe 80 per cent or more of the cottagers come from Toronto. The 50 per cent isopleth marks the outer limit of the summer dormitory zone of Toronto.

area in which from 90 to 100 per cent of the cottagers come from Toronto is of interest. It does not form a semicircle with the center at Toronto, but is constricted on the western side, where there is little recreational land. This area is entirely in the buffer zone of Toronto, in which there are few cottagers. Thus, while Toronto is important to the area, the area is not important to Toronto from a recreational standpoint.

Because nearly 90 per cent of their cottagers are Torontonians, the resorts of Lake Simcoe are effectively part of the ecological city of Toronto. No other Resort Area of comparable size may be so justly included within ecological Toronto.

In the southeastern corner of Georgian Bay, on the Muskoka Lakes and on Rice Lake, Torontonians, in spite of their large numbers, make up only from 60 to 70 per cent of the cottagers. They are diluted, in the first Resort Area, by people from the urban complex in southwestern Ontario; in the second, by Americans and people from all over Ontario; in the third by people from nearby towns. These conditions are paralleled in the southwestern corner of Georgian Bay, the Lake of Bays, and the Kawarthas, respectively, where little more than half the cottagers are from Toronto.

The 50 per cent isopleth delimits the summer dormitories of Toronto. Individual resorts will be found beyond this limit where Torontonians predominate—particularly among the 30,000 Islands of Georgian Bay—but in general Torontonians are outnumbered by people from the rest of Ontario and the United States.

Sociological Implications

We have seen that the intensity of recreational land use is greater for Toronto than for the rest of the province. We must be careful to remember, however, that Toronto exhibits all the complexities of a major city. The ecological zonation that Burgess was the first to suggest is exceptionally well illustrated here: business center, transition zone, working-class homes, well-to-do homes, suburbia, are all well defined. As I have suggested in the foregoing, at least one more zone should be added to these: the *summer dormitory zone*. In Toronto this is separated from the city proper by a *buffer zone*, which may be called a *recreational bridge*.

It is not enough to say that so many cottagers go from Toronto to such and such a resort; it is essential to give the section of Toronto that they come from. The zonation of the city finds a rough extension in the zonation of summer resorts. Thus, the people from poorer districts, when they own cottages, own them in resorts that are close to the city; those from well-to-do districts are able to range farther afield, to less closely settled areas with better recreational endowments. (There is even an ecological zonation in individual resorts, as the author has discovered in an extended study of Wasaga Beach, as yet unpublished.) Indeed, the ecological processes of invasion and succession play a major part in the creation of resort zones, and are nowhere more clearly demonstrable; areas close to the city were fashionable when only the well-to-do could afford cottages, and became less fashionable as leisure, recreation, and cottage-owning became democratized. Similarly, well-to-do gentile cottagers have abandoned once-fashionable resorts as Jews have begun to move in.

About 10 per cent of the population of Toronto is Jewish, and therefore Jews are conspicuous in the summer

dormitories of Toronto. Segregation in the American South is scarcely more rigid than is the enforcement of restrictive covenants in many Ontario resorts. As a result, Jews have become segregated into specifically Jewish resorts, of which Lake Simcoe has the largest number. Here again, the zonation of the city is extended to the country, and the social and economic stratification of the Jewish community is paralleled in its summer resorts.

Surprisingly, no evidence was found in the post office lists of cottage colonies of other ethnic groups, but undoubtedly these exist. Several reasons present themselves for their inconspicuousness, the most important of which, perhaps, is that exclusion of other ethnic minorities, comparable to the Jews in number of well-to-do families, is less rigid than that of the Jews.

No mention has been made of a very important question: the relation between commercialized resorts and private-cottage colonies. Since such resorts were specifically excluded from the post office lists, they will not be discussed here.

RELIABILITY OF THE ANALYSIS

In the Introduction it was admitted that "it is impossible to say how representative a sample of the summer resort population of Ontario is given by the (post office) list. . . ." Are there, then, no controls by which the reliability of our figures can be tested?

We cannot know what the actual number of cottagers in Ontario is, nor does the validity of the above analysis depend on this knowledge. We have interested ourselves only in the relations between various groups of cottagers, and we have confined ourselves to interpreting the percentage distributions. The question of reliability thus resolves itself to: how reliable are our percentages?

For a test of reliability we need sets of figures arrived at independently of the post office lists. Municipal clerks, for example, are asked to report the numbers of summer residents in their municipalities; their estimates, however, turn out to be valueless.

At present I have useful figures, not dependent on the post office lists, for only two sizable resorts—Grand Bend, on Lake Huron (Division VIII), and Wasaga Beach, on Georgian Bay (Division VII). These are given in Tables VIII and IX. The figures for Wasaga Beach ratepayers are completely reliable: all the ratepayers included are cottagers, and I believe the list is complete. The Grand Bend assessment rolls, however, include properties that are not cottages; I have removed from the rolls all properties owned by residents of Grand Bend, and hope that most of the properties we are not interested in have thus been eliminated. It is possible that the Grand Bend post office list includes cottagers at the nearby resorts of Oakwood and Beach o' Pines; in Column 5 of Table VIII, accordingly, the assessment rolls of these resorts have been added to that of Grand Bend.

We are not concerned with the absolute figures, and therefore need not look for correspondences between them. But our percentages all correspond as well as we could have hoped. Compare, for example, the percentages of Torontonians in Grand Bend and Wasaga Beach; in the former the post office list and the assessment rolls agree that Torontonians are about 5 per cent of the whole; in the latter the post office list and the ratepayers' list agree that they are about 60 per cent of the whole. It is significant that in both resorts there is no discernable relation between the percentages of cottagers and those

TABLE VIII

COTTAGERS AND TRANSIENT VISITORS AT GRAND BEND (DIVISION VIII), 1941, 1947, 1948

From	*Assessment Rolls, 1947*[a]	*Post Office List, 1941*	*Post Office List, 1948*	*Post Office List, 1948 (Owners Only)*	*Assessment Rolls, 1947 (Plus Oakwood and Beach o' Pines*[b]	*Transient Visitors 1947 (Hotel Registers)*[a]
	(1)	(2)	(3)	(4)	(5)	(6)
A. Absolute Numbers						
London	108	116	165	107	159	89
Toronto	11	18	29	13	14	88
Rest of Ontario[b]	123	100	137	79	167	230
Rest of Canada	...	1	3	...	...	3
Detroit	23	32	61	34	37	209
Rest of Michigan	18	4	16	10	31	108
Rest of United States	9	7	16	8	10	37
United Kingdom	...	...	...	...	...	2
Total	292	278	427	251	418	766
B. Percentages						
London	37.0	41.7	38.5	42.6	38.1	11.6
Toronto	3.8	6.5	6.8	5.2	3.3	11.5
Rest of Ontario[b]	42.1	36.0	32.1	31.5	39.9	30.1
Rest of Canada	.....	0.4	.....	.....	.....	0.4
Detroit	7.8	11.5	14.3	13.5	8.9	27.2
Rest of Michigan	6.2	1.4	3.8	4.0	7.4	14.1
Rest of United States	3.1	2.5	3.8	3.2	2.4	4.8
United Kingdom	.....	.....	.....	.....	.....	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

[a] After N. L. Nicholson: "A Geographic Study of the Watershed of the Ausable River, Ontario"; unpublished M. S. thesis, in Univ. of Western Ontario, 1947. Used by permission, but the way it is used is my own responsibility entirely.

[b] Properties owned by permanent residents of Grand Bend have been omitted from the Assessment Rolls: 177 from Column 1, 187 from Column 5.

TABLE IX

COTTAGERS AND TRANSIENT VISITORS AT WASAGA BEACH (DIVISION VII), 1941, 1948

	Ratepayers, 1948[a]		*Post Office List, 1941*		*Transient Visitors, 1948*[b]	
	Number	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*
Toronto	183	62.0	170	59.1	733	27.4
Rest of Ontario	101	34.3	109	37.8	1,095	41.0
Rest of Canada	...	.....	1	0.3	35	1.3
United States	11	3.7	8	2.8	802	30.0
Europe and Asia	...	.....	...	.....	7	0.3
Total	295	100.0	288	100.0	2,672	100.0

[a] Compiled from file of ratepayers at Wasaga Beach Chamber of Commerce.

[b] Compiled from visitors' register at Wasaga Beach Chamber of Commerce; most stayed at cabins and hotels.

of transient visitors. This is entirely in agreement with what we have found to be true for Ontario, and, indeed, for Canada as a whole (Fig. 2).

In another respect our analysis is much less reliable. The post office list for 1948 shows many important differences from that for 1941. While the total numbers of cottagers were similar —28,159 and 29,375 in 1941 and 1948, respectively—there were significant differences in their distributions. Individual resorts showed marked changes, but much more important was the

omission of some post offices and the addition of others. Thirty-four that reported in 1941 were missing in 1948; there were 23 new ones. The post office whose omission in 1948 affects our analysis most strongly is that of Hamilton Beach, for an entire Major Division (VI) has been wiped out. In 1941 only the summer residents of Toronto Island were listed; in 1948 they were almost exactly the same in number, but they were overlain with an almost equal number of permanent residents, as was the case with Hamilton Beach in the 1941 list. On Lake Simcoe the Jewish invasion of certain resorts had progressed. The important resort that is a suburb of North Bay is omitted in both years, and this, as has been noted, gives our results an unwelcome bias.

After all changes have been accounted for, however, the over-all pattern detectable in the 1948 list is sufficiently similar to that in the 1941 list to make us confident that our analysis is meaningful. Our analysis, I repeat, has not been definitive; I hope that it has been suggestive.

ALASKA, LAND OF OPPORTUNITY—LIMITED*

Wilford J. Eiteman and Alice Boardman Smuts

Professor Eiteman of the University of Michigan is the author of several books in his field of specialization, finance. He spent part of World War II in Alaska as an O.P.A. Price Executive. This is the fourth magazine article he has written as a result of this experience. Mrs. Smuts, a free-lance writer also interested in Alaska, assisted him in his research.

OLD-TIME grammar school geographies depicted Alaska as a barren land of ice and snow incapable of supporting more than a handful of miners, trappers, and Eskimo. Since Pearl Harbor magazines and newspapers have been extolling the region as a veritable promised land of milk and honey, capable of supporting "five million inhabitants" (according to one writer). Since thousands of persons at one time or another have seriously contemplated emigrating to the Territory, it is desirable that the public be given a realistic picture of what Alaska really is like and what it has to offer prospective settlers.

The present popularity of Alaska stems from the assignment of great numbers of people to the Territory for war purposes. Defense considerations made it necessary to station several hundred thousand servicemen there. Additional thousands of civilians followed to build airfields, improve harbor facilities, maintain and operate supply routes, and otherwise aid in the defense program. Startling facts and strange accounts of the region brought back by these wartime emigrants have caused the old picture of a bleak land to give way to a concept of a Utopian land of superabundant resources, possessing agricultural possibilities beyond description.

Fortunately modern Alaskan pioneers will not have to worry about obstacles of the kind that confronted pioneers of the West. In fact, the Territory's settlers may have difficulty recognizing themselves in a role of "pioneers" for they will arrive via streamlined planes or luxurious steamships; they will lodge temporarily in hotels some of whose accommodations are equal if not superior to those of hotels "outside"; they will find buses, taxicabs, supermarkets, beauty parlors, theaters, and night-clubs waiting to serve them. The truth of the matter is that the hardships dramatized by writers and lecturers really do not exist in the settled parts of Alaska where most migrants would make their homes.

But the *economic* limitations and hardships that will confront "Alaskan pioneers" are not illusionary by any means. The proposition that Alaska can support millions is fantastic. Indeed, the assertion that Alaska can support two or three hundred thousand people should be classified as extremely optimistic. The area of Alaska is one-fifth that of the 48 states together. Yet its prewar white population was

*The research and the collection of the statistical data upon which the conclusions of this article rest were made possible by a grant from the Social Science Research Council.

only 39,170. If the Territory is able to absorb another 40,000 in the next two or three decades, it will be fortunate. A few salient facts will serve to temper enthusiasm and to direct discussion of the Territory's future into more practical channels.

First, let us point out that neither statistics of Alaska's natural resources nor facts relating to her envigorating climate or the fertility of her soil have any real bearing upon the Territory's future. *Physical* resources and *economic* resources are not synonymous although many people fail to see a difference. An easily accessible deposit of iron ore is a physical resource but it is not an economic resource unless its location is more convenient to the market than other equally-rich iron ore deposits. It is absurd to predict the future of a region like Alaska on the basis of an itemization of its physical resources.

PATTERN OF EXPLOITATION

Before plunging into an economic analysis of the Territory, it would be revealing to glance briefly at Alaska's past. It is Alaska's curse that her peculiar physical characteristics have always encouraged greedy exploitation. Nature stocked her mountains, valleys, and fiords with huge quantities of easily attainable wealth but at the same time failed to endow the country with qualities that encourage people

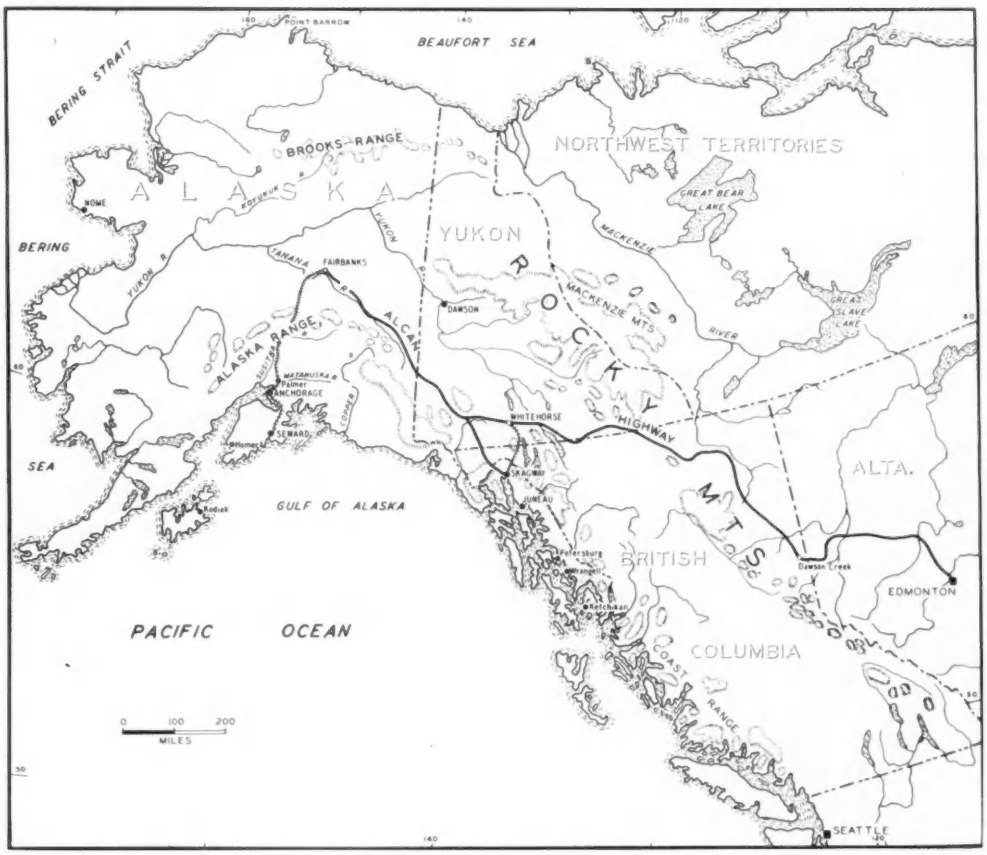

FIG. 1. Location map.

to settle down and to build homes. The Alaskan poet, Pat O'Cotter, noticed this and used it as a theme for a poem. He suggested that God, growing weary after six days of toil creating the world, threw the rest of his material in a heap off to the side, and consigned the region where it lay to the Devil.

The Devil grinned as he stood and gazed.
Said he, "This is just what I need.
It's the place of my plan for the downfall of man,
Where I'll change his ambition to greed."

The Devil rearranged the material so as to make Alaska a hell on earth and then,—

Knowing full well that men would not go
To a land so forlorn to behold,
He salted the hillsides and some of the streams
With nuggets and traces of gold.
He tinted the hills with a green copper ledge
And covered the valleys with game,
All this for a lure, which the Devil felt sure
That the white man would fall for the same.

THE FIRST "GOLD" RUSH

The Russians were the first to be attracted by the "Devil's lure." Peter the Great planned an expedition to the new world for the purpose of discovering whether or not the western continent was joined to Asia. Intended as a scientific expedition, it ended as a commercial enterprise. The explorers reached the Comador Islands in 1741. Here a storm destroyed the ship and forced the Russians to spend the winter in caves and ravines subsisting on roots, animals, and fish. As a consequence of their enforced stay they were present to witness the coming of the sea otter the following spring. They slaughtered thousands of the little animals and as soon as the weather permitted built a ship and carried the skins back to Russia. The cargo brought such a high price that each crewman made a fortune from the expedition. News of the rich find spread quickly and initiated the first stampede to the Territory.

The hunting of the sea otter was confined at first to the islands nearest to Russia, but as the animals became scarce the hunters were forced to go farther and farther east until finally they passed Kodiak and were sailing up and down the coast of North America as far south as the present site of Sitka. By 1867 the sea otter and the sea cow, which was also hunted extensively, were almost extinct. Not knowing of the gold and copper hidden away in the mountains, the Russians decided that the Territory was no longer worth the cost of defending and sold it to the United States for $7,200,000.

THE SECOND "GOLD" RUSH

Many Americans considered the purchase of the region as foolish. It was referred to as "Seward's folly" and as "an ice-box." Then, in 1896, a discovery of rich placer deposits in the Klondike led to a second stampede to Alaska. Within a few weeks and months strategically located Alaskan communities of 20 and 30 persons increased to several thousands. Nome grew from practically no population to over 15,000. (It has less than a thousand now.) Practically none of the prospectors planned to settle permanently in Alaska. Most of them expected to loot the region of its gold and then return to the States.

THE THIRD "GOLD" RUSH

Back in 1898 a party of gold seekers threading their way through the mountains, gorges, and glaciers of the Copper River Valley on their way to the Klondike found a "mountain of red metal" (copper). Although the newly found deposit was unusually rich and easily mined, it was located 190 miles from the coast, requiring transportation of ore over terrain of the most difficult type. The transportation cost of the

first metal brought out was $100 per ton. To exploit the deposit, the Kennecott Copper Company built a railroad at a cost of $20,000,000. The huge investment proved profitable, however, for approximately 90 per cent of all Alaskan-produced copper has come from this unique deposit, *i.e.*, more than a half million tons worth in excess of $200,000,000. By 1938 the deposit was exhausted, the mine was closed down, and the railroad was abandoned. Today, the population of the region is dwindling.

THE FOURTH "GOLD" RUSH

Even before the gold rush was over salmon fishing was beginning to prove lucrative. In most cases local canneries were owned and financed by absentee owners who opposed the establishment of government in Alaska except insofar as it was to their own interests to have law and order maintained. The fishing industry brought some permanent residents to the Territory, especially to southeastern Alaska, although even today it is the custom for thousands of fishermen from the States to go to Alaska for the fishing season only.

More of the fortune seekers and adventurers would probably have remained in Alaska if government policy had favored settlers rather than exploiters. In 1898 there were 30,493 white people in Alaska; thirty years later (1929) there were only 28,640 whites. During the decade of the 1930's the white population increased 11,500, chiefly as a result of the depression existing in the States.

FIG. 2. Matanuska Valley farm near Palmer, Alaska. (Courtesy of McCutcheon's Foto Service, Anchorage, Alaska.)

ECONOMIC ANALYSIS

The economy of Alaska is often compared with that of the Scandinavian countries to prove that the region can support millions of people. It is true that Alaska and Sweden are similar in climate, latitude, and physical resources. Unfortunately, it is the difference not the similarities that are significant to Alaska's future. The most important of these differences is Sweden's proximity to markets and Alaska's distance from them. More than a *hundred* million people live within 700 miles of Stockholm, Sweden. Less than *one* million people live within 700 miles of Ketchikan, Alaska's most accessible city. The hundred million people located near Stockholm live in industrial countries (Germany and England) which lack the particular raw materials most abundant in Sweden. By contrast, most of the million persons "near" Alaska live in Vancouver, Canada, or in Seattle, Washington, regions whose resources are of the same type as those of Alaska. Thus Sweden ships lumber to England where lumber is scarce. If Alaska exports lumber, she must ship it *via* Seattle where lumber is one of the principal products. Even disregarding transportation costs, the cost of producing lumber in Oregon and Washington is less than the cost of producing it in Alaska. Add to this the fact that the North-Pacific states are closer than Alaska to the consumption centers and it becomes clear why Sweden's forests

are *economic* resources while Alaska's forests are just *physical* resources.

Sweden possesses the richest iron ore deposits in the world. She mines, smelts, and ships the metal to a customer only 500 miles distant (Germany). Alaskan iron ore is of lower quality. Furthermore, the nearest important markets lie east of the Mississippi River, more than 3000 miles away. To make matters worse, higher quality ore is mined in the Lake Superior region very close to consumer markets. Thus, until a steel industry is firmly established on the Pacific coast, high transportation costs will keep Alaskan iron deposits in the classification of *physical* rather than *economic* resources.

What has been said of Alaskan iron and lumber does not apply to salmon, gold, and fur. Alaska produces seven-eighths of the world's supply of salmon. Consequently she dominates the market and is in a position to demand and receive a price high enough to pay any transportation charges. In addition, salmon are so abundant in the waters of Alaska that the cost per pound of catching and canning them is low even though wages of fishermen and cannery workers are high. Gold and furs have such high market value in proportion to their bulk that transportation costs to distant markets are not significant. As long as their supply remains abundant, their cost of acquisition will also remain fairly low.

Most of the resources suggested as a basis of new Alaskan industries do not possess the unique economic characteristics of salmon, gold, and furs. For example, it has been pointed out that Alaska has enough forests to supply one-third of the United States newsprint needs. This may be true, but Alaska forests will not be used for this purpose as long as the domestic and Canadian forests are able to supply American paper requirements at lower prices. Lumber for construction purposes is milled in Juneau, Sitka, and Ketchikan, but it has not been possible to market this lumber in the Territory outside of the towns where the mills are located. Residents of Seward, for example, find it cheaper to import lumber 1,200 miles from Seattle than to buy it 600 miles away in Juneau. The cost of shipping lumber from Seattle to Seward is only slightly more than the rate for shipping it from Juneau to Seward. The cost of producing lumber in Juneau is much higher than the cost of producing it in Washington and Oregon. Hence, Juneau lumber cannot be exported with profit to the States nor even sold in other parts of Alaska in competition with outside producers. Consequently, local mills are forced to limit their production to the needs of the vicinity in which they are located. An exception is Sitka spruce cut in the neighborhood of Ketchikan and shipped to Seattle for use in the manufacture of airplanes.

Turning next to Alaska's great store of minerals, we see again that it is not the *quantity* of iron, zinc, copper, and lead that determines the future of Alaska's mining industry, but the *richness* of the deposits, the *cost* of extracting the minerals, and the *ability* of Alaskan producers to compete with outside producers in distant markets. We have already discussed iron and gold mining.

The other minerals—lead, zinc, and copper—are bulky and have a low value per pound. Markets are distant and consumption centers are even more distant. The cost of mining these minerals plus the cost of shipping them to market are so great as to render their exportation unprofitable in view of the relatively low price at which they must be sold. Very rich deposits of copper can be mined profitably in Alaska but, as

we mentioned earlier, the richer copper deposits of Alaska have been depleted. Such lead and zinc as are currently produced in the Territory are by-products of gold and silver mining.

THE FUTURE OF ALASKAN AGRICULTURE

Most of those contemplating migration to Alaska have farming in mind.

FIG. 3. Matanuska Valley dairy farm. (Courtesy of McCutcheon's Foto Service, Anchorage, Alaska.)

There are three areas in the Territory where the environment is suitable for agriculture: the Matanuska Valley, the Tanana Valley, and the region around Homer. In the first two, large tracts of land are already under cultivation and yield abundant crops. Development of agriculture around Homer has lagged due to inadequate transportation facilities.

In the case of agriculture, also, there are significant differences between Alaska and Sweden. The broad interior valley where Sweden's farm lands lie is in Southern Sweden. Alaska's large valley, the Yukon, is in the North where the weather is too cold for most forms of agriculture. Sweden's valley opens southward toward her markets; Alaska's valley points westward away from her customers. Sweden's mountains act as a protection from bad weather. Alaska's mountains act as a barrier to trade.

Up to the present the high level of local prices has made farming in Alaska profitable. Since Alaskan farm production has never been able fully to supply local consumptive needs, retailers are forced to import some food of every kind from Seattle. For example, large quantities of imported canned milk are regularly sold in Palmer, the heart of the Matanuska dairy farm region. The Alaskan retail price of imported foods is the Seattle wholesale price *plus* transportation charges *plus* the retailer's mark-up for handling. The higher the transportation charge, the higher the price of the imported article. It is the present Alaskan farmer's good fortune to be able to sell his produce at the prices set by merchants for imported products, even though he does not have to pay freight charges from Seattle. Thus high Seattle-to-Alaska freight rates afford Alaskan farmers a measure of protection from outside competition in much the same way as a protective tariff protects domestic producers from competition of foreign producers.

The Alaskan farmer could lose this advantage in two ways: (1) he might expand production to the point where importation would be unnecessary or (2) transportation costs might be lessened. If farmers flock to Alaska in such numbers as to make it possible for farm production to supply the needs of Alaskan consumers, importation will cease and farm prices will drop to lower levels. If agriculture should expand to the point where production *exceeds* Alaskan needs, it will become necessary to export surplus products to the next nearest market. This would probably be Seattle and would mean that prices of farm products in Alaska would henceforth be Seattle wholesale prices *minus* transportation charges. If and when

Alaskan agriculture reaches this point, territorial farmers will find themselves in the same plight as farmers in the United States were during recent periods of low farm prices.

It should be pointed out that Alaskan farmers are not in immediate danger of any of these pessimistic happenings for the industry can stand doubling or trebling. But doubling or trebling Alaskan agriculture means adding two or three thousand more persons, not millions or even hundreds of thousands.

EXPANSION OF EXISTING INDUSTRIES

Up to this point we have been concerned with showing why the iron, lumber, and agricultural industries of Alaska cannot be expanded far beyond their present scale of operations. There still remains the question of whether Alaska's three major industries—salmon, gold, and fur—can be expanded to give employment to postwar immigrants. Unfortunately the answer is no.

Consider gold mining first. Most people who go to Alaska to mine gold have placer mining in mind since lode mining requires enormous investment in machinery and equipment and can only be carried on by large corporations such as the Alaska-Juneau Gold Mining Company. Expansion of lode mining depends upon the decisions of corporate executives and Wall Street bankers and not upon the number of immigrants who happen to be seeking work.

Most of the persons now engaged in mining operations are connected with gold mining. A rapid expansion of placer mining will only deplete the Territory's placer deposits that much the quicker. Geological forces required millions of years to form gold ore and to transport it to places where it can be panned. It takes but a few decades of intensive mining to exhaust high quality placer deposits. Man invariably mines the richest deposits first and then moves to poorer and poorer deposits until forced to cease mining altogether because the deposits left do not warrant the cost of working them. A decline in the cost of living sometimes prolongs the period during which mining continues to be profitable but the end is inevitable: only the timing is uncertain. Under the circumstances, gold mining does not offer promise of supporting large numbers of permanent residents in the Territory.

Something of the same type of reasoning applies to the salmon industry. To prevent depletion of this resource it is necessary to maintain a balance between the rate of catch and the rate of reproduction. Any attempt to increase the present catch so as to give employment to additional residents will lead only to the extinction of salmon.

What has been said of the salmon applies also to the trapping of wild animals. At present the hardships of a trapper's life maintain the necessary balance between catch and reproduction. A large influx of hunters is not apt to occur but, if it did, it would lead to an extermination of fur-bearing animals similar to that of the sea otter and the sea cow by the Russian hunters.

The islands that fringe the coast of Alaska are ideal for fox farming since one has only to purchase a small island and allow the animals to run wild. Fox farms already exist there and the market for furs could absorb larger quantities than at present without adversely affecting prices. However, the weather in the coastal regions is too mild to develop the highest quality furs whereas the winter weather and other factors in the interior are too severe to be attractive to most prospective immigrants. It must be admitted however that fur-

animal farming does offer some prospect of limited development.

DEVELOPMENT OF NEW MANUFACTURING

The economic salvation of the Territory, say some, depends upon the building up of new manufacturing industries. Manufacturing industries usually find it advantageous to locate between the source of cheapest raw material and the location of the largest body of consumers. Obviously Alaskan manufacturers cannot do this. Except for salmon, gold, and furs, raw materials found in Alaska are not cheap. It is doubtful if Alaskan producers could afford to import raw materials for manufacture. Consequently such manufacturing as may develop must take the form of converting local raw materials into goods for local consumption. Of necessity such industries will be small. Obstacles to inter-regional trade were illustrated in the case of lumber. The principle involved has broad application. Unfortunately it happens to be a fact that existing schedules of transportation charges permit Seattle producers to sell in every Alaskan community while at the same time confining sales of Alaskan industries to their local community. The remedy involves raising Seattle-to-Alaska rates and lowering intra-Alaska rates but to date no one has ever advocated increasing a freight rate connected with Alaskan traffic.

EFFECT OF IMPROVED TRANSPORTATION

Many of those who urge millions to settle in Alaska assume that improved transportation is the magic cure-all, a panecea for all of the Territory's economic ills. They contend that the Alcan Highway, new air routes, and possibly a U. S.–Alaskan railroad would end Alaska's isolation from the rest of the world and so remove the barrier to its future development.

The Alcan Highway was built to serve military, not commercial, needs. The road is long, it is impassible most of the year, and it is difficult at all times. Its upkeep is extremely expensive and it is separated from the principal Alaskan cities by high mountain ranges. Under the circumstances it is doubtful if the amount of traffic that would normally flow between the United States and Fairbanks, Alaska (a city of five or six thousand) would justify the cost of maintaining a road more than 2000 miles long.

Air transportation is fast but is not cheap. It may aid the tourist trade but it is not serviceable for shipping such bulky resources as ores, fish, and lumber. In some respects a United States–Alaska railroad is more practical. Such a road, if constructed, probably would follow a north and south route just to the east of the Coast Range (see map) or it might parallel the Alcan Highway. It would be better if it could skirt along the coast so as to be able to serve the cities of southeastern Alaska but the rugged coastal terrain with its precipices, hanging valleys, fjords and glaciers would present insurmountable engineering obstacles. The construction of a United States to Alaska railroad might reduce transportation costs of bulky articles to the cold sparsely populated interior valley of Alaska (the region about Fairbanks) but the road would never be able to earn more than its expense of operation nor to pay a return on its investment.

It is significant to note that not all Alaskans stand to profit from cheaper transportation. The first effect of lower freight rates would be lower prices of imported products. As we have pointed out, this would be a *boon* to the salmon and gold mining industries

but a *burden* to Alaskan industries attempting to provide goods to Alaskan consumers. If Alaskan producers understood the full significance of lower transportation charges it is doubtful if so many of them would continue to advocate lower freight rates.

ALASKAN PARADOX

A review of the conclusions reached above does not leave one optimistic about the Territory's economic future. Existing industries—fishing, gold mining, and fur trapping—are profitable but offer little or no prospect for expansion. Alaska's distance from world markets precludes exploitation of many of her most abundant physical resources. Farming in the Territory is capable of doubling, trebling, perhaps even of quadrupling, but when the increase is stated in absolute figures the number of new farmers is small. Development of small-scale manufacturing is possible only to a limited extent.

But a contrasting picture of the Territory can also be painted. It is a fact that fortunes are being made there every day. For example, it is estimated that a thousand fishermen support their families by catching the legal limit of beaver. A few weeks of hard work yield these men a sizeable annual income and enable them to *save* the entire proceeds of their fishing activities.

Which then is right, the somber analysis of Alaska's future or contradictory conclusions based upon actual experiences of the inhabitants? Paradoxically, the answer is "both." The economy of Alaska is simple and easily described (see "The Economic Basis of Prices in Alaska," *The American Economic Review*, June 1944, p. 351). Nature has supplied the Territory with an abundant supply of *natural* resources. However, Alaska is so distant from heavily populated areas of the world that many of its natural resources cannot be exploited profitably. Exceptions, in the order of their importance, are fish, gold, and furs. In a nutshell, inhabitants of the region produce and export these three items and use the proceeds of the sales to purchase and pay for the goods they import. Thus, the number of inhabitants that the area can support is limited by the quantity of imported goods that can be acquired in exchange for the three principal export products. As pointed out, any attempt to expand the output of the export industries will by their nature lead to their quick exhaustion. It will be noted that the legal limit for beaver hunting will remain what it is only as long as the number of beaver hunters is small. The rather extreme case of the beaver-hunting fishermen illustrates a characteristic of most Alaskan opportunities: they vanish when too many attempt to exploit them.

Another way of stating this is to say that remarkable opportunities for earning a livelihood exist in Alaska, but for individuals, not for crowds. It is difficult to make casual observers realize this; to see that future migration to Alaska must remain an individual matter; that if it is carried out on a wholesale scale, it will lead to disaster. Only those who have lived in Alaska fully appreciate this truth.

Some type of planning must be undertaken, however, if a reoccurrence of the exploitation so characteristic of Alaska's past is to be prevented. Plans for the Territory's future must be *economically realistic* as well as *engineeringly practical* if Alaska is to have a sustained development and not merely a temporary spurt of prosperity. They must recognize the mutual interdependence of Alaskan industries so that small advances in one field will be accompanied by similar advances in the other fields and result

in balanced development. Above all progress must be gradual. It will be impossible to make up for seventy-five years of neglect overnight. Finally, planners of Alaska's future should encourage migrants who desire "good living," not those in search of "quick riches." The aim should not be to make migrants rich but to insure economic security for the settlers, for their children and their children's children.

The Territory has much to offer individuals who enjoy outdoor life and informal living. It has very little to offer multitudes. The best advice that can be given to prospective migrants is to acquaint themselves with Alaskan ways of life and with the limitations on the region's future. If after doing this, they are still interested, then by all means they should heed the popular cry to "Go North." Such persons will find more truth than poetry in the sourdough's boast that "Alaska is really God's Country."

THE SALINES OF SOUTHEASTERN CALIFORNIA

Wesley Calef

Dr. Calef, Assistant Professor of Geography at the University of Chicago, visited the salines region of southeastern California in the autumn of 1941 and returned to the region for further investigation in the summer of 1945. He specializes in the human-use aspects of physical geography. *(Manuscript received April, 1949.)*

ALMOST the entire world production of borate minerals comes from a small area in southeastern California; in fact, from two tiny spots within this small area. This is true despite the fact that known deposits of borate minerals occur in various parts of the world, and despite the fact that the list of uses for the product is a very long one. This same tiny area produces a significant portion of American production of one of our most vitally needed fertilizers, potash. It furnishes most of our supply of lithium salts, a mineral of steadily increasing importance in our industrial economy, even though rocks containing significant portions of lithium are much more widespread. Other salts are produced also, and though this production is of minor importance in national or world totals it is of increasing importance to the rapid industrialization of the West Coast.

Few mining enterprises in North America have been better known to the general public than the saline mines of southeastern California. This is the more surprising considering the relatively small size of the operations whether measured on a tonnage or a value basis.

During one brief episode in the history of the development of these deposits borax was produced at Death Valley, a highly picturesque area, and transported by 20-mule team and wagons across the desert to the nearest railroad. The difficulties of the enterprise, the unusual nature of the operations and locale, a considerable amount of publicity in the newspapers, and the fact that the product of the principal producer was marketed under the name of "20-mule team" and widely sold for domestic use served to bring these deposits to public attention everywhere in the United States.

Despite the comparatively small size of the operations, the salines of southeastern California constitute a most important and interesting group of deposits. From a mineralogical and geological viewpoint the deposits are unique. The uses of the industry's products are widespread and in some cases admit of no substitutes. Hence a dependable supply within the United States is invaluable. Their importance was attested during the Second World War by the industry's high priorities for obtaining the supplies necessary to some of their operations.

Moreover, the history of the exploitation of these deposits mirrors within an easily observable compass many of the major trends and aspects of mineral developments around the world. Consequently, an intensive study of their development may help

to shed light on some of the general questions of mineral exploitation and development.

BEGINNINGS OF PRODUCTION

The earliest production of salts in California did not occur in southeastern California but, instead, took place in Lake County, about 80 miles north of San Francisco. The presence of a high proportion of borate salts in the waters and muds of Clear Lake was discovered in the 1850's, but it was not until 1864 that a company was organized and a plant built to exploit these deposits.

The method of working was to scrape up the muds from the bottom of the lake, wash away the mud and the smaller borate crystals, dissolve the remainder in water, and then crystallize out the borax. Though production reached a total of 220 tons in 1867, the entire production from northern California did not reach 700 tons. Since the operations were confined to a lagoon on Clear Lake the raw material had nearly reached exhaustion when a rise in lake level made the dredging of the bottom muds no longer feasible, but production was continued intermittently in a nearby locality until competition from new sources forced abandonment of the operations.

EARLY PRODUCTION IN SOUTHEASTERN CALIFORNIA

Some of the most forbidding country of the Great Basin and Mojave Desert furnished the locale for the next exploration and exploitation of salines. In Death Valley and other interior basins scattered throughout the area to the east, west, and north are dry lakes or playas. During the period from 1870 to 1880 it was discovered that the muds and surface encrustations of many of these lakes contained concentrations of borates (see Fig. 1 for principal names and locations). Some of the largest producers were located in Nevada and the remainder were in adjacent parts of California. For a period of 20 years the muds of these desert basins were the source of borax for the United States.

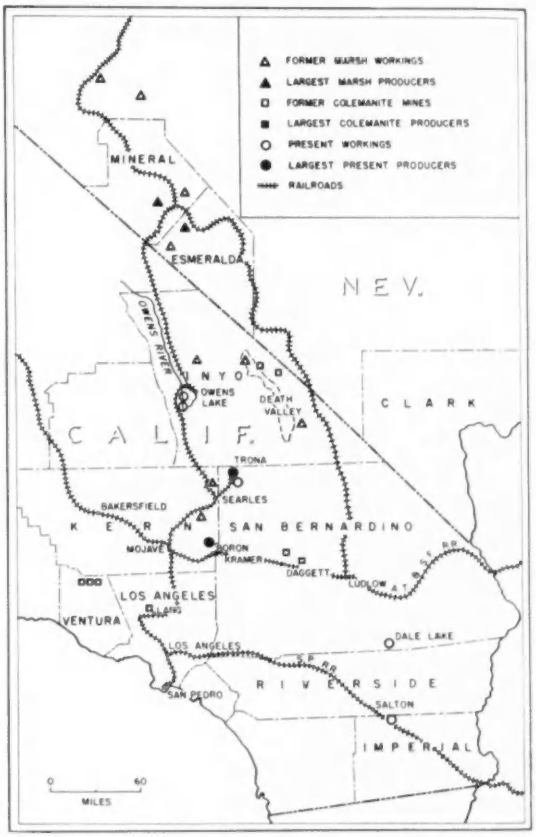

FIG. 1. Principal sources of borate minerals, both historical and present, in southeastern California and adjacent portions of Nevada.

The major topographic outlines of the area are the same as those of the rest of the Great Basin. The mountain ranges run approximately north and south, exhibit considerable linearity, and are roughly parallel. In the western part of the Mojave this situation does not obtain; the mountains have a much less regular arrangement and are much lower. Though there is variation from

one range to another they consist, for the most part, of complexly folded and faulted, generally somewhat metamorphosed sediments. There are, however, large igneous bodies present.

Surrounding these ancient mountains are broad pediments or large alluvial fans which form the margins between the mountains and the basins. Many of the basins appear to be perfectly level. This is particularly true near the center of the larger ones, but toward the margins the slope increases greatly. They are all characterized by internal drainage. Near the center of the basins but always in the lowest part occur one group of the saline deposits. These are known by a wide variety of names—"dry lakes," "mud flats," "alkali marshes," "soda lakes," "borax lakes," "playas," "bolsons," and others. With the exception of Owens Valley none of these basins contained a permanent lake. The extent of the playa seems to bear little relation to the size of the basin.

The playas are of two main types: (1) dry playas and (2) wet playas. The first is much more prevalent. Dry playas are either permanently dry or have only a very thin sheet of water for a few days during a period of heavy precipitation. Most of the dry playas have no observable concentration of salts. The surface consists of smooth clay, baked by the sun and covered with cracks which divide it into small blocks. The surface is hard and solid throughout most of the year, but toward the end of the rainy season it becomes a very thin crust underneath which is a sticky thick mud. Some of the dry playas do have concentrations of salt at the surface; but they are thin, and drilling has nearly everywhere failed to reveal any important salt bodies underneath, or, for that matter, many highly saliferous clays or muds beneath the surface.

Wet playas are areas where lakes exist during the rainy season in most years. These ephemeral lakes are always shallow and as they dry up leave a large expanse of sticky mud. During the dry season wet playas have a crust, light in color and often dusty, beneath which is found a watery mud containing varying concentrations of salts.

In most cases the salts do not occur singly (though there is commonly a predominant salt) but in highly complex mixtures of the calcium, potassium, and sodium compounds of the carbonates, sulphates, chlorides, nitrates, and borates.

The two chief sources of borate minerals during this early period were the muds of these desert playas and surface efflorescences which occurred on the flats occupied temporarily by ephemeral lakes. A long period of volcanic activity took place in this region during the Tertiary. The waters and gases associated with this vulcanism brought boron to the surface, probably in the form of boric acid, where it reacted with calcium and sodium to form the various borate minerals. With the waning of volcanic activity hot springs and fumeroles doubtless added to the supply. The two forms of borates that are found in these marsh or mud deposits are borax and ulexite. Both of these materials are soluble in water. Borax was probably laid down by the evaporation of lake waters containing quantities of sodium borate and, of course, was mixed up with any other salts which happened to be in solution. Ulexite (sodium-calcium-borate) seems to be, at least in many cases, closely associated with rising underground water and occurs in the upper foot or two of mud of the bed of a former lake. Consequently, the distribution of ulexite is very patchy, and only small parts

of a large dry-lake bed will contain fairly rich beds of ulexite.

Ulexite occurs as balls or masses (not crystalline) of fibrous appearance (hence the oft-used name "cotton ball" borax) imbedded in the lake bottoms in a mass of sediment. In some dry lake basins efflorescence has deposited a shining crust of borax on the surface. Moreover, if this material is scraped off the process will begin again, and a few months is a sufficiently long time to bring about the formation of a new crust.

In order to concentrate and refine the borax from these impure deposits fairly extensive "works" were necessary. The concentrating plants were crude and rough. In the case of the efflorescences, teams and scrapers were used to scrape up the surface deposit into windrows from which the material was loaded in wagons and hauled to the plant. The mud deposits were shoveled. On arrival at the plant the raw material was shoveled into vats of boiling water heated by steam coils. The borax would go into solution almost completely in the hot water; and the impurities, or at least a large portion of them, would settle to the bottom. After the solution had completely clarified, the liquid containing the borax was drawn off into shallow wooden tanks and allowed to evaporate under the brilliant sunshine and heat of this arid climate. This process resulted in a product containing a good many impurities even by the then-existing standards which were none too high.

Sometimes this material was shipped for further refining elsewhere, but in other cases the initial product was further refined at the site. The additional refining consisted of repeating the same process of boiling and evaporation which resulted in the further removal of impurities.

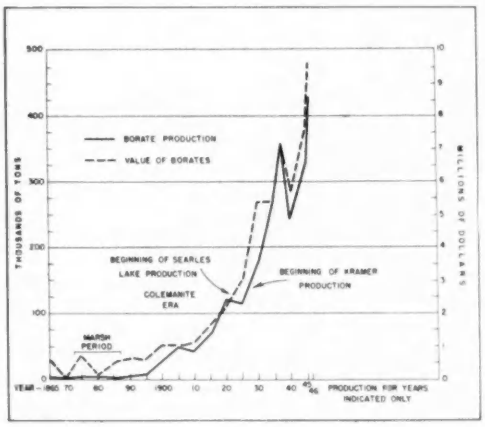

FIG. 2. Borate production and value in the United States at five-year intervals. (U. S. Bur. of Mines data.)

The process just described will work, however, only if the raw material contains only borate salts. As already noted, this is not the usual case. If the deposit contains other soluble salts it is obvious that they will be left as residues of the evaporation process along with the borax. Consequently, in many cases a different method of treatment had to be employed. The raw material was dumped into boiling water to get rid of the mud silt and sand. Then the boiling liquor was drawn off and cooled very rapidly. The rapid cooling was accompanied by the precipitation of borax while the other salts largely remained in solution. The remaining liquor was then drained or siphoned off.

Most of the producers were unscientific and untrained amateurs and their methods were crude and experimental. Often they used "hunches" in their processes. Several disgusted allusions exist in the scientific literature of the day to the nonsensical methods employed in refining. One modern chemist maintains that so impure were even the refined products that they could not now be marketed at any price.

The difficulties facing these early

producers were tremendous. Except for these small islands of activity the country was uninhabited. The greatest problem was transportation. De Groot describing a trip to one of these desert basins, wrote in 1890:

> Arriving in Mojave the rest of the way must be made by team, no stage running over this portion of the route. There are, in fact, no stages or public conveyances to be found in any part of this country. If the distance is long it cannot be made on horseback, owing to want of feed and water whatever the route pursued.

Transportation costs were high. The transportation cost of borax shipped from the Nevada deposits to refineries in San Francisco was $12.50 per ton. The haul of over one hundred miles by 20-mule team from Death Valley to Mohave, the railroad point, with its attendant difficulties of high summer temperatures, lack of water, and roughness of terrain, to mention only the most obvious, is merely typical of the transportation problems faced by these early producers. It was stated at the time that the cost of getting borax from Searles Lake to Mohave was greater than from Mohave to eastern markets.

The desert conditions made for other difficulties. Potable water for domestic purposes was commonly unavailable, and ordinarily had to be brought by iron pipe a distance of two or three miles from the adjacent mountain ranges. All feed for the work animals had to be imported, and the same was true of food for the workers.

Fuel was necessary for heating the water in which the raw material was dissolved. During the early years of operation the fuel was obtained by cutting mesquite, sagebrush, and greasewood in the immediately surrounding area. But very shortly the supply of this material was exhausted and had to be replaced by crude petroleum which also had to be imported. So great was the summer heat in some areas that early promoters made much of the fact that even though the works might need to be closed down during the summer the operations throughout the rest of the year would still be profitable.

Despite the difficulties and the crude technology borax production increased rapidly with the exploitation of one after the other of these marsh deposits. Numerous companies were producing. Since the size of each operation was small, tiny deposits of salt could be worked, and this whole area is dotted with small deposits. Production did not originate continuously from the same deposits. Difficulties of technology and marketing caused several companies to become bankrupt. Some were reorganized; others permanently disappeared. Some small deposits were largely worked out.

None of the operations was on a large scale. Two of the largest workings employed about 30 men each in the actual processes of mining and concentrating. A very considerable part of the labor force was engaged in the transportation of the borax to the railhead and in importing the necessary supplies and materials.

The top production year in northern California, 1867, had seen a production of 220 tons of borax. The first real year of borax production from the marsh deposits saw production soar to 1,000 tons. The following year it reached 2000 tons, and in 1875 and 1876 it exceeded 2500 tons. Though the disparity between the two states was not great, production from Nevada was greater in every year except 1876. The largest single producing locality was Teel Marsh in Nevada (Fig. 1), probably followed by Columbus Marsh. The latter was the scene of the first exploration of these playa deposits.

The larger deposits exploited and the

subsequent rise in production did not, however, result in any sensational prosperity for the mining companies involved despite the very high prices prevailing at the beginning of this period. A number of factors enter into the explanation. Previous to the development of the California and Nevada deposits nearly the entire world supply of borates had come from Italy, Chile, and Turkey. All of these properties were controlled by a British syndicate which had control of the market. The extremely high prices for borax were, therefore, in a sense artificial. Moreover, the demand for boric acid and borax at anything approaching the existing prices was not quickly elastic. Consequently, placing on the market any considerable additional quantities of borate materials was certain to have a depressing effect on prices.

The new California and Nevada producers, in order to get capital for their enterprises, made such extravagant boasts concerning the tremendous amount of borax they would be able to produce that these reports alone were sufficient to drive down the price for their product. It presents a rather interesting spectacle: a group of producers talking themselves out of a high price for their product.

No one will be surprised to discover that there was almost immediate agitation for the imposition of a higher tariff on borates to protect the home producers. When, in 1883, Congress enacted this higher tariff, the law was made to become effective six months after passage. During this interval the British merchants sent unusually large quantities of borates to the United States to enter before the tariff went into effect. This had a disastrous effect on prices in the United States; but it was not entirely to the detriment of the British borate suppliers, because some of their leases on some borate properties were up for renewal, and the thought was that a depressed market would offer a good opportunity for renewing the leases at relatively low prices.

Regardless of the weight assigned to the various causes for the price decline, the market value of the salts dropped steadily. In 1864 borax had sold for as high as 39 cents per pound or $780 per ton. Throughout most of the 1860's it had sold for over $700 per ton. By 1873, the first year of major production from the marsh deposits, the price had dropped to 24½ cents per pound. The decline continued steadily until by 1879 borax was selling for only 9 cents per pound. This price was coincident with the lowest production ever achieved after 1872. Both production and price then turned upward; but, though production continued to rise until 1887, prices very quickly reversed themselves and continued their steady drop. By 1884 they were back to 9 cents per pound, and they continued to drop a cent or two per pound every year until 1887 when they reached a low point of 5¾ cents per pound or $115 per ton.

The three great uses for borax during this period were for the glazing of pottery (possibly the foremost use), as a water softener, and as a preservative for meats. It is interesting to note the destination of the borax shipped. The principal markets for borax were, of course, in the East. One refinery was located in Chicago, one in New York, and another in Bayonne, New Jersey. Some of the largest consumers were the big potteries in Trenton, New Jersey; East Liverpool and Cincinnati, Ohio; and Philadelphia.

Approximately 45 per cent of the borax was shipped east by rail. Another 40 per cent went to New York by sea, and about 14 per cent was shipped to Liverpool. However, the shipments to

Liverpool did not represent net export. It was as cheap to ship borax to New York by way of Liverpool as to ship direct. Consequently, sellers would often ship borates to Liverpool; but if upon their arrival the New York market was higher than the Liverpool price the borax would be forwarded to New York. If the Liverpool price was higher the borax would be sold in Liverpool. So great was this importation of borax from the west coast by way of Liverpool that a large proportion of the "imports" of that period represents this domestic production.

THE COLEMANITE ERA

In 1882 a new borate mineral, colemanite, was discovered in Death Valley, California, and in 1883 another deposit of the same mineral was discovered near Daggett, California, not far from the line of the Santa Fe Railroad. Although mining did not commence until 1887, the discovery of this mineral was the first step in a complete revolution in the salines industry.

The colemanite minerals occur in bedded deposits, and in a few favored areas these beds are massive and extensive; hence the amount of borate material is much larger than in the marsh deposits. Colemanite was originally deposited as ulexite in extensive and long-lived lakes which existed during the Tertiary. Ulexite, it will be remembered, is sodium-calcium borate. Colemanite is calcium borate. It is believed to be the result of the leaching out of borax (sodium borate) from the original ulexite beds, thus leaving the calcium borate (colemanite).

One extensive discovery of colemanite was made a short distance north of the town of Daggett on the Santa Fe Railroad. The proximity of this deposit to railway transportation gave it a tremendous, in fact insuperable, advantage over other extensive deposits of the same material which occurred in southern Nevada and in the Death Valley section of California. When this mine near Daggett, the Calico mine, came into production the number of borax workings decreased very rapidly; production from the marshes dwindled and disappeared (Fig. 3).

Another significant change occurred in the organization of the industry. In 1888 the company which owned the Calico mine had a major competitive advantage over its rival companies. It bought some of them out and, in the words of one contemporary reporter, "took hold of the industry." This company, the Pacific Borax Company, and its successors dominated the production and marketing of borax in the United States for the next 30 years. In some years this company had an almost complete monopoly of borax production in the United States. Much of the time this company's production probably ran around 85 per cent of the total United States production and never fell far below this proportion, although exact figures are not available. The story of the saline workings in southeastern California thus becomes largely a description of the activities of this company and a few minor competitors.

The colemanite was mined with ordinary underground mining methods. The Pacific Borax Company made no attempt to produce either borax or boric acid at the site of the workings. Instead, the raw material was concentrated and shipped east by rail for refining at the company's large refinery in Bayonne, New Jersey. Other independent refineries were located at New Brighton, Pennsylvania; Brooklyn; Chicago; and San Francisco.

The method of concentrating the borates was simple. Heating removes the water from the colemanite and it is

reduced to a fine white powder. The clay and other materials by which it was surrounded hold their consistency. Consequently, after calcining, the material had merely to be screened and bagged to be ready for shipment to the eastern refineries.

A further horizontal combination of the borax industry in 1899 still further modified the situation. A group of British capitalists formed a firm called Borax Consolidated, Limited. This syndicate acquired control of the world's commercial sources of borax. Borax Consolidated, Ltd. also bought the physical properties of the Pacific Coast Borax Company. This firm had been organized by Mr. F. M. Smith, a very shrewd and capable mining man, and his associates. The Pacific Coast Borax Company received a third of the shares of Borax Consolidated, Ltd. in payment for the properties in California which had been turned over to Borax Consolidated. Moreover, Smith also bought for cash enough additional shares to give him voting control of Borax Consolidated, Ltd. In other words, a complete world monopoly of borax had been established, controlled by the group of California borax producers.

The ownership situation had a strongly stabilizing effect on the price of borax and to a lesser extent on production, though the latter was more subject to fluctuations in demand.

By 1906 a loose combination of the borax refining companies of Chicago, San Francisco, and New Brighton, Pennsylvania, and some small borax

FIG. 3. Calico Mine near Daggett, California. For a period of nearly 20 years this was the major source of borates for the United States. Note the desert conditions and especially the small amount of equipment used in the operations. (Courtesy Pacific Coast Borax Company.)

producers and chemical companies had been formed. Among other properties this group had some fairly high grade deposits in Ventura County, east of Bakersfield. Although these deposits were rather far (35 miles) from a railroad, this distance was not absolutely prohibitive so far as transportation costs were concerned. Unfortunately, the area was not served by a good road; hence, the mines operated only about seven months per year, the dry season. But, in 1907, an extensive and rich deposit of colemanite was discovered at Lang in northern Los Angeles County, and this property came under the control of one of the members of this new small combination. Thereafter, there was available a good competitive source of borate supplies.

It must not be thought that there were no other borax producers at this period. Several small companies operated for various lengths of time and produced small amounts of borax and boric acid. There were even a few attempts during this period to work some of the marsh deposits, but the total production from all of these small operations was only an insignificant part of United States production.

The presence of competitors in the field does not appear, however, to have influenced notably the situation with regard to price and supply. Certainly it did not greatly interfere with the profits of Borax Consolidated, Ltd., as evidenced by the financial reports for the four years 1910–1913. The dividends paid on the common stock amounted to approximately 12½ per cent, 13 per cent, 14 per cent, and 15 per cent for the four consecutive years.

As has been previously noted the dominant position of Borax Consolidated, Ltd. in the market brought about a leveling off of prices. For the next two decades the price of borax ranged around six or seven cents per pound. Production, however, was subject to greater fluctuations. As contrasted with the 5500 tons produced in 1887, production in 1888 dropped to 3900 tons. Production did not greatly exceed the 1887 figure until 1899 by which time the total annual production was 20,357 tons. The enormous effect which the discovery and exploitation of these large, high grade, more easily worked colemanite deposits had on consumption and production of borates in the United States is best illustrated by the fact that production in the year 1899 was almost half again as great as the total production from all the marsh deposits and the northern California deposits throughout their history. And production was as high or higher throughout the next three years. One factor in the rapid increase in demand for borax was its increasing use in the manufacture of enamels. About one-half of the borax consumed during this period was for use in enameling kitchen pots and kettles and in the manufacture of sanitary ware.

The same year, 1907, that saw the discovery of the Lang deposits also saw a major shift in the point of production of the Pacific Coast Borax Company. The Calico mine of the company was approaching exhaustion. The company had long owned very large deposits of colemanite in Death Valley, but the exploitation of these deposits had not been possible because of their remoteness from a railroad. However, with the approaching end of production from the Calico mine and the development of other types of mining operations in southwestern Nevada, a company headed by F. M. Smith of Consolidated Borax was organized to construct the Tonopah and Tidewater Railroad from Ludlow on the Santa Fe to Death Valley and beyond to the other mines.

This railroad reached the vicinity of Death Valley in the summer of 1907, and all the operations of the Pacific Coast Borax Company were transferred to the Lila C. Mine in Death Valley. During the early operations the concentrated colemanite was hauled by wagon to the Tonopah and Tidewater, but very shortly a spur track was constructed right up to the mine mouth.

The bonds of the Tonopah and Tidewater Railroad to the extent of over $3,000,000 were guaranteed by Consolidated Borax. Other types of mining in southwestern Nevada did not prove as extensive as had been hoped, and the principal source of income for the railroad was the borax traffic. The railroad never operated at a profit though the large amount of freight furnished by the borate mines kept the annual deficits rather small.

By 1914 the Lila C. Mine had been largely worked out and the company again had to transfer its activities to the Biddy McCarthy and Monte Blanco Mines in Death Valley. This necessitated building a new spur track to the mines, and in the same year a new calcining plant was built at Death Valley junction on the railroad line.

The year 1914 also saw a very important change in the control of borate production. Mr. F. M. Smith who had been the principal figure in the borax industry was an extremely able mining man; but he had invested the profits from his mining properties in various other financial enterprises, particularly transportation and real estate, and these investments did not turn out so fortunately. He eventually found himself in serious financial difficulties, and was forced in 1914 to dispose of his holdings in borax. They were sold to the English syndicate which had been formerly the minority group in Borax Consolidated, Ltd. Thus control of the world's output of borax passed to this group and out of the United States.

Besides the shift in control of the borax industry to England, 1914 saw the beginning of certain other changes which were to have a profound effect on the salines industry of southeastern California. It saw the beginnings of a series of events which were eventually to bring about the exploitation of two giant new sources of chemical minerals. These two tremendous deposits are at Searles Lake in extreme northern San Bernardino County (Fig. 1) and at Boron, just west of the San Bernardino County line, near the line of the Santa Fe Railroad in Kern County, California.

How have these two deposits come to dominate the scene? What is the peculiar combination of geological factors that makes these two spots different from other widespread areas of this portion of the Mojave that superficially seem to be nearly identical? Why were the deposits not exploited earlier? What has been the effect of their development on the industry? Since the deposits are notably different and the means of exploiting them totally different they will be considered separately.

THE KRAMER BORATE MINES

Along the highway in the vicinity of the Kramer borate mines there is almost nothing in the landscape to indicate their presence. Driving west from Kramer through the seemingly typical, empty desert country one passes through the tiny hamlet of Boron with its few small stores, some gasoline pumps, a few houses, and that is all. A dirt road leads off from the highway but disappears in a few yards over a slight rise in the terrain. In a couple of minutes this tiny oasis has been left behind. No significant change in the terrain is visible. But only three miles to the north are the greatest borate

mines in the world, mines which furnish a major proportion of the present world consumption of borate minerals, mines which have produced nearly as much borax as all the other deposits in the world combined.

The borates of the Kramer district are not at the surface, but lie between 300 and 1000 feet underground. Since the deposition of the borates, the area has been subjected to some deformation so that the borax now lies in a great oval-shaped body with a synclinal or basin structure.

The remarkable feature of the deposit is the enormous accumulation of pure borate minerals not intermingled with other types of chemical minerals. It consists of great thicknesses of borax and kernite interstratified with layers of clay and sediment. This is a unique situation. No similar deposit is known anywhere in the world.

The two principal minerals of commercial importance are borax and kernite. The nature of borax has already been discussed but the kernite has not. Kernite is merely a form of sodium borate containing less water than borax. Hence, mining pure kernite should result in a greater volume of borax than the amount of kernite mined as the additional water is absorbed. In places the kernite changes to borax upon exposure to air during mining operations. Colemanite and ulexite are widespread throughout this district, found both outside the main mass of kernite and borax and also interstratified and occurring as lumps and veins within the kernite-borax main mass.

The volume of this deposit is truly colossal. As mentioned previously, this deposit has already produced more borax than any other deposit in the world. It has produced approximately two and a quarter million tons of crude borates, and estimates of the amount still available place the quantity at fifty times the amount already produced, and possibly much more than that.

The deposit varies in thickness from 30 or 40 feet to known thicknesses as high as 110 feet and some fairly reliable reports indicate areas with thicknesses in excess of 200 feet.

All other known deposits of borate

FIG. 4. Concentrating plant at Kramer borate mine of Pacific Coast Borax Company. Note the large size but simple construction of the buildings. (Courtesy California Division of Mines.)

minerals have associated with them various other sulphides, chlorides, carbonates, etc. What are the peculiar conditions that have brought this gigantic accumulation of almost pure borate minerals?

Like all the other borate deposits the one at Kramer is the result indirectly of volcanic activity. From the geological evidence it appears that the borates accumulated in a basin which received the flow of water from numerous hot springs and other sources during the period of volcanic activity in this area.

The water flowing toward this interior basin was probably flowing over beds of hot volcanic rock. Consequently, the waters containing the borates were greatly concentrated by evaporation before they reached the lake. They were also very hot. The lake into which the water was flowing was broad and shallow. The hot waters spread out over the surface of the lake and cooled rapidly. The borax was precipitated out first, exactly as in the old marsh process previously described. This precipitation was not attended by the precipitation of other minerals. As the lake dried up all these other saline minerals should have been precipitated; but these other minerals are not there. Hence, the postulate is that the lake had an outlet, and before these other minerals were deposited the waters drained out through the outlet and thus were removed from the Kramer basin.

At the same time that the borax was being precipitated some quantities of mud and clay were also settling, thus forming the deposit as it exists at present except for the presence of the kernite. This kernite is assumed to be the result of subsequent heating of the borax which was originally deposited. However, if the lake water had been sufficiently hot it could have precipitated kernite directly.

If the geologists' explanation of the process of accumulation is correct, it would appear that similar occurrences may have taken place at other points either within the Mojave or in other parts of the world. However, the peculiar combination of circumstances attending the formation of the Kramer borate beds would not very likely be found in many other places, and we cannot be too optimistic about finding similar deposits.

The original discovery of borate minerals in the Kramer district was made as early as 1914 when low grade deposits of colemanite were discovered while drilling a well in the vicinity. A deposit this close to a railroad would of course be a property of major value. Hence, once the discovery of borate minerals in the Kramer district had been made almost continuous exploring for a commercial deposit of borates took place. But it was not until 1925 that the great mass of kernite and borax was discovered.

Three separate companies sank shafts and began producing borates from the deposit. The early years of production were marked by considerable litigation as to ownership. Eventually, however, all three companies came under the control of the Pacific Coast Borax Company which has been producing from the deposit ever since.

The underground production of the borates is done by ordinary mining methods, and only beneficiation or concentration of the ore is done at the mine site. A shaft is sunk into the various layers of borax and kernite, and tunnels and drifts are driven out from the shafts. The mine supports are pillars of the mineable material. Either pure kernite or borax could be mined; but a mixture of the two is the common

practice, because a mixture is easier to concentrate and crush. About one-fourth of the material mined is the enclosing and interbedded clay and shale. After being brought to the surface the material is crushed by grinding, heated to remove most of the water, and much of the associated sediment is removed by mechanical methods. The material is then loaded on railroad cars for shipment to the company's refinery at Wilmington, California, near Los Angeles harbor.

Because the volume of material handled is large, the buildings for ore concentration are extensive but not very elaborate (see Fig. 4). The only other structures near the site of the deposit are some low barracks built by the company and used as living quarters by many of the workers.

SEARLES LAKE

The Searles Lake basin, one of the most desolate of all the basins of the northwestern Mojave Desert, is so formidable and inhospitable to human occupance as to be almost bizarre. The low, barren, tan, gray, and brown ranges bordering the basin drop off abruptly to the low-angle, smooth slopes of the basin which lead down gently to the shores of the lake. The few, scanty, stunted, desert shrubs only emphasize the general barrenness. The lake adds to the strange aspect of the basin. It is a huge sheet of glistening salt, brilliant in the bright sunshine of the desert. No fresh water is available in the basin. The whole basin is surrounded by miles and miles of uninhabited desert. Certainly few places on earth seem less likely spots for human habitation. But within this basin is a comfortable, modern, little community, Trona, of well over a thousand people; with stores, electric lights, a telephone system, recreation facilities, and comfortable homes. Comparatively near the lake are two large, modern chemical plants. These plants support the inhabitants of the basin. The plants are based on the enormous accumulations of saline minerals found in Searles Lake.

Searles Lake is the last remnant of an interior-basin, saline lake which must have existed for a very long period. The surface of the lake has a solid, salt crust approximately 10 feet thick, which is sufficiently stable to support a truck or auto. The top layer of the crust is almost pure sodium chloride, but the underlying layers are made up of other salts of peculiar and unusual character and composition. Below this crust the salts contain sufficient water so that they are not a solid but a liquid brine. Approximately one-third of the total volume of the brine is made up of solids.

It is believed that at least a trace of all the chemical elements is to be found in the Searles Lake brines. The brines are a highly complex mixture of the chlorides, carbonates, sulphates, and borates, principally of the cations of sodium and potassium. In recent years lithium has also become a matter of great commercial importance though it makes up only a small fraction of one per cent of the solids in the brine.

The volume of salts in the lake is gigantic. The surface of the lake is approximately 12 square miles. Much of the brine is from 75 to 200 feet in depth. G. R. Robertson, writing in 1929, cited the following information to give some concept of the amount of brine present. "The industry removes nearly 400 tons of product daily, and throws back into the selfsame lake the rejected residue of 1500 tons of worthless salts. Despite the wholesale throwback, analysts have been unable in 10 years to measure a change in composition of the lake brine as great as the probable error of their determination."

As we have already noted earlier, however, there are other saline lakes and other wet playas in this section of California. Why then are there not similar developments of brines or complex salts in some of these other basins?

The Searles Lake deposits differ from the other saline lakes and playa deposits in two important characteristics: (1) they are enormously larger than similar deposits existing in other basins, and (2) the underlying salts and brines are almost completely free from sediments, in contrast to other basins where the salts make up only a small part of the total sedimentary layers. Obviously, such an unusual situation must be the result of an unusual geologic history, and such is the situation.

Searles Basin is one of a series of four adjacent basins lying in close juxtaposition in this area. The northernmost of these is Owens Valley. Owens Valley is 140 miles long and consequently drains a very considerable area. Even today the Owens River is one of the few perennial streams of the Great Basin.

During the period of greater precipitation and consequent expansion of the lakes in the Great Basin during the Pleistocene, the lake at the south end of Owens Valley became so deep that it overflowed through the pass at the lower end of the basin into the next basin to the south. South from Owens Valley the water spread into a broad shallow basin called Indian Wells Valley. Here the sediment in the stream was largely precipitated. Indian Wells Valley acted as a settling basin. When this basin had been filled the waters flowed across a low divide into the next basin, Searles Basin. But the lowest pass by which water might leave Searles Lake was at a fairly high elevation. Consequently, the water had to stand at a high level and be constantly fed by a large stream to cause this basin to overflow. The result was that the overflow from the Searles Basin was of relatively short duration, and all the salts brought into both the Owens and Searles Basins were deposited in Searles Lake. Furthermore, this saline concentration was not accompanied by the usual deposition of huge quantities of sand, gravel, silt, and clay, since most of this material had already been removed in Indian Wells Valley. The gradual desiccation of this long-lived, large lake in Searles Basin has resulted in the present Searles Lake deposit.

In 1863, J. W. Searles, while on a prospecting trip, crossed the basin that now bears his name. A few years later, when interest in borax was high because of the current high price, Searles was shown a sample of borax. Surmising that the deposits he had seen in the Searles Lake area might be borax he returned to the area, and eventually began producing small amounts of borax from the surface efflorescences around the margin of the lake. Production was not very successful though it continued until 1895. Various attempts were made from time to time to utilize the brines, but they were uniformly unsuccessful because no commercially valuable salt can be made to precipitate from the complex brine at any naturally occurring temperatures. For nearly 20 years no significant attempts were made to try to utilize the Searles Lake brines.

The first successful exploitation of Searles Lake brines was the recovery of potash. With the outbreak of the First World War the United States suddenly found itself cut off from its German suppliers of potash. The result was an almost fantastic rise in the price paid for the small available supplies of potash, and the beginning of intensive efforts on the part of the federal government and numerous groups of private

investors to discover sources of potash within the United States.

Some years previous to the war the United States Geological Survey had discovered the presence of potash in the Searles Lake brines. A company, the American Trona Corporation, had been formed to try to exploit the deposit. It had not been very successful. The rest of the lands around the lake had been withdrawn from entry by the government in view of the fact that they were potash lands. It is interesting to note that the plant of the American Trona Company was located on land belonging to the Pacific Coast Borax Company. However, the land of the borax company did not extend into the lake itself, because the original claim had been made to exploit the surface efflorescences on the land surrounding the lake.

The new potash enterprise differed from the others in that it was backed by large amounts of capital, and it made use of the resources and techniques of chemical science to work out the problems of separating the desired salts from the other constituents of the brine. After some preliminary investigations of the best methods of handling the brine an experimental plant was set up on the shore of the lake. It proved not too successful and was eventually discarded. Thereafter very extensive chemical experiments, often with large amounts of brine, were made in the company laboratories in New York and elsewhere.

In 1915 the company built a new plant and began the production of potash salts. A railroad line, standard gauge, was built from the lake to the nearby Southern Pacific line. Large supplies of capital were absolutely necessary to the success of the enterprise. Only slowly did the plant get into production. A full-time research staff was set up at Trona to work continually on the various problems of handling the brine.

By 1917 production had reached 30 tons of potash per day and the "plant was in practically continuous operation." But production increased steadily and by the end of 1917 had reached more than 50 tons per day.

During this same war period other companies attempted exploitation of these brines. It will be recalled that a subsidiary of the Pacific Coast Borax Company owned some land adjacent to the lake. Consequently, Pacific Coast Borax joined with the Solvay Company and constructed a plant for the purpose of winning potash from the brines. They were not as successful as the American Trona Company, but by 1917 they had reached a production of only 200 tons per month. Though there was a good deal of land available for lease from the government no one else attempted to enter the field.

By 1917 the Searles Lake deposit had become the second largest source of potash within the United States. In 1918 production from Searles Lake doubled, the two operating companies having a total capacity of 25,000 tons per year. By 1918 a new company, The Westend Consolidated Mining Company, was also building a plant on the shores of the lake and shortly thereafter entered production.

It is worth while noting that long before the Trona Corporation had successfully produced potash and before they even contemplated the production of borax the high percentage of boron in the brine led mining industry observers to predict that Searles Lake would eventually become a strong competitor of the erstwhile-dominant Borax Consolidated, Ltd. for the world market in borax.

The end of the war and the rapid

reduction in the price of potash that followed caused all the plants then producing from the Searles Lake brine to close. The rather inefficient processes that had been developed plus the high freight rates to the large eastern markets would not permit a sufficient return on the investment.

However, the development of new processes to produce more than one product from the brine brought success. At this particular time the British syndicate that owned the property

FIG. 5. Searles Basin, the village of Trona, and the plant of the American Potash and Chemical Corporation. Part of Searles Lake in the foreground. (Courtesy of American Potash and Chemical Co. and Coy Watson Photos.)

decided, though on just what basis is not definitely known, to dispose of the property, and it came under the control of Consolidated Gold Fields of South Africa, Ltd. This corporation was controlled in turn by the German Potash syndicate. No attempt was made to alter the management of the company though what effect the sale had on prices charged for potash is not known.

With a research staff constantly working on the problems of the separation of the various salts in the brine, through the years more and more products have been successfully isolated. Success with the chemistry of the brine has enabled the company continuously to expand the scope of its operations. In 1923 it produced 30,000 tons of potash salts and 14,000 tons of borax. Production continued to increase. In 1933 the existing production facilities were doubled. The result was that despite the rise of the New Mexico potash deposits the Trona deposit produced over 40 per cent of the United States total and slightly less than 10 per cent of the world production of potash. Almost every year saw additions to facilities or the production of new product[illegible]nd World War saw a[illegible]ndous expansion of the [illegible]nt.

At the present time the company produces muriate of potash, refined potassium chloride, sulphate of potash, soda ash, salt cake, desiccated sodium sulphate, borax, boric acid, lithium concentrates, bromine, and bromides. It is also contemplating the production of tungsten.

The plant is a triumph of modern chemical engineering. Continuous research has resulted in ever cheaper production and production of a greater variety of products.

Almost everything is done mechanically. The slush-like brine is pumped from the lake by electric pumps and run through the various processes under very close control by skilled chemical engineers. The dried products are handled by blowers wherever possible. The result is that though the various products must be separated from the brine by expensive chemical methods, these chemical costs are offset by the fact that there is practically no cost of mining; hence the deposit can compete with the various other sources of their products where nature has long ago gone through the complicated chemical processes now carried on at Searles Lake and left the products needing only mining and perhaps refining.

It was noted earlier that the absentee owners of the major producing company were outside of the United States. In October, 1942, the *New York Times* reported:

> "German ownership of most of the capital stock and control of (The American Potash and Chemical Company) was disclosed by the Alien Property Custodian when he announced on October 20, 1942, the vesting in him of 90.79 per cent of the capital stock of the company owned by German nationals. The property vested consisted principally of 474,726 shares, registered in the names of Consolidated Goldfields of South Africa Ltd., Gold Fields Ltd., Administrickantoor Diligentia, all of which are beneficially owned by Winters[illegible] A. G., Germany (dominant factor in the German Potash industry) and Salzdetfurt[illegible], A. G., Germany (second-largest potash company in Germany)."

Thus we have the extremely unusual situation of a nation which for a period of over 40 years was overwhelmingly the leading producer of borax and throughout most of that period all the commercially exploitable deposits were controlled by financial combinations outside the country. This is the more unusual in view of the complete shift in sources of production that had taken place during that period.

Eventually, the Alien Property Custodian disposed of the capital stock of the company through a syndicate of New York investment banking firms. A stipulation of sale was that all stock had to be sold to United States nationals. It is now widely held. Some is now owned by employees of the company, but the principal stockholder is the Heyden Chemical Company.

OTHER SALINE DEVELOPMENTS IN SOUTHEASTERN CALIFORNIA

Owens Lake is similar to the other lakes and basins which have been described. It is an interior basin lying between the Sierra Nevada on the west and the Inyo Mountains to the east. It is the largest of all the lakes of this region. During much of its history the Owens River, draining the west flank of the Sierras, flowed into the lake. However, since the flow of Owens River has been almost completely diverted for the Los Angeles municipal water supply system and for irrigation in Owens Valley, the lake has largely dried up. It has now become essentially a bed of salt with small amounts of brine in the interstices.

FIG. 6. Part of the residential section of Trona. Note the extreme desert conditions. (Courtesy of California Division of Mines.)

As early as the 1880's attempts were begun to wrest some salts from the waters or bordering deposits of Owens Lake. The earliest operations attempted to obtain sodium carbonate. The water from the lake was pumped into vats and allowed to evaporate by solar heat. Since trona (hydrous sodium carbonate) is the first salt to precipitate, evaporation was allowed to continue until another salt began to come down. Then the brine was drawn off. The trona forms a solid crust at the bottom of the evaporating pan or pond. Subsequently, it was shoveled up, heated to drive off the water, and soda ash was produced.

In view of the simplicity of the chemistry of the operation it is not surprising that production of sodium carbonate and sulphate has continued

intermittently up to the present. For many years production of sodium carbonates was greater than that of borates. At various times several companies have been involved in operations at Owens Lake. Despite the fact that the operation is not particularly complicated several companies have gone bankrupt or abandoned their operations, and some of the properties have subsequently been taken over by the companies operating at present.

The present methods are somewhat similar to the old methods except that the sodium carbonate is caused to precipitate as a sludge by the introduction of carbon dioxide obtained from nearby limestones.

Three companies now operate in the area. They produce mainly soda ash, though one of the companies produces borax. This company is a subsidiary of the Pittsburg Plate Glass Company, the latter thereby producing its own borax for use in the manufacture of glass.

With the tremendous expansion of industry on the West Coast and the national shortage of soda ash since the end of the war, the production of sodium carbonate from these saline deposits has been of particular importance in recent years.

Since 1940 two new sources of sodium sulphate have come into production. The American Sulphates Company began production of sodium sulphate from some open-cut mines of magnesium-sodium salts in Imperial County. Production was highly mechanized, but has been intermittent in recent years.

Another producer of sodium sulphate is located at Dale Lake near the southern boundary of San Bernardino County. The deposit is essentially similar to other wet playa deposits. The brine of the semi-dry lake contains about 22 per cent sodium chloride and about 7 per cent sodium sulphate. Seven wells have been driven near the center of the lake. The brine is pumped into vats and by evaporation and chilling the sodium sulphate and sodium chloride are recovered. This is one of the few examples in the entire history of these salines where sodium chloride has been recovered and shipped. It is sent to the Basic Magnesium Company in Las Vegas, Nevada.

There is also an extensive bedded deposit of anhydrous sodium sulphate near the southern end of the lake. This also is mined by power shovels and processed into commercial sodium sulphate. Since the deposit is located about 30 miles south of the Santa Fe Railway, the product is hauled to the railroad by huge trucks capable of carrying a load of 30 tons. Only 20 men are employed.

PRODUCTION AND PRICES

Until the 1920's the principal natural sodium substance produced in the United States (excepting common salt) was sodium carbonate; but with the

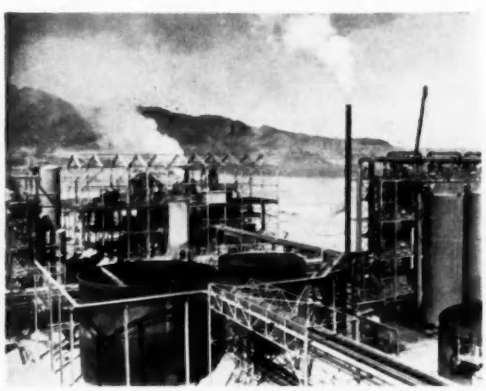

FIG. 7. Part of the maze of equipment in the American Potash and Chemical Corporation plant at Trona. This view of part of the works gives some notion of the size and complexity of the chemical processes carried on in the plant. A recent addition to production facilities is the carbonation plant pictured above. In this plant, soda ash and borax are produced from deep-level brine of Searles Lake. (Courtesy of California Division of Mines.)

drop in prices which followed the development of the present sources, the borates became the leading product.

It will be recalled that during the colemanite period the price of borax had ranged around six or seven cents per pound. By 1925 the price had dropped to about 27 dollars per ton or 1.3 cents per pound. In 1935 borax was valued at less than a cent per pound. Even with the high prices of 1946 the price of borax reached only slightly more than 22 dollars per ton or a little in excess of a cent a pound.

The drastic drop in prices stimulated production enormously. From 1915 to 1925 production almost doubled (Fig. 2). In 1935 it was far in excess of twice what it had been in 1925. By 1946 production was over 3½ times as great as in 1925 and had increased more than sixfold over 1915.

Normally, between 35 and 45 per cent of the total United States production of borax is exported. The United Kingdom is the largest foreign consumer of borax; during an average year it takes about a fourth of the total exports. During the early and middle thirties, Germany was a close second, receiving about 22½ per cent of the total United States export. Other principal consumers are the Netherlands (12½ per cent), France and Japan (9½ per cent each), and Belgium (5 per cent).

Ninety per cent of all the borax leaving the country goes through the port of Los Angeles. About 3 per cent leaves from each of the ports of New Orleans and Galveston. However, during the recent war the Gulf ports handled most of the export trade.

Only a small fraction of the total United States production of potash is exported. However, about two-thirds of these exports go to Japan, and this is furnished in large part by the California salines. It is obvious that the California producer is in a strong position in the Pacific market. However, large demands for potash in the United States will probably keep exports low.

Now that we have traced the development of the salines industry of southeastern California and have described the present industry and its resources, how does it fit into the national and international picture? What of its future?

THE SALINES IN THE NATIONAL AND INTERNATIONAL SITUATION

The naturally occurring salt deposits of southeastern California are major factors in the national and international production of three minerals—borax, potash, and lithium.

Practically the entire world's production of borax is derived from Owens Lake, Searles Lake, and the Kramer borate mines. The latter is overwhelmingly the leading producer in the world. Borax is a highly versatile substance. According to W. T. Schaller "Hardly any other substance enters into so many diversified lines of manufacture."

Over half of present-day production goes into the manufacture of porcelain-like coatings for bathtubs, kitchen sinks, kitchen enamelware (pots and pans), stoves, refrigerators, and similar uses. Another major use for borax is in the manufacture of glass. In fact, during the war it was the major use. Borax improves the tensile strength, hardness, brilliance, and elasticity of the glass. Consequently, the finished product will stand more abuse from heating, bumping, washing, and other handling. Borax is also used in the manufacture of detergents. This latter promises to be of increasing importance. A considerable amount of borax is used in the manufacture of other chem-

icals. It is sold widely as a water softener. Boric acid is in wide use as a mild antiseptic. Mixed in large proportions in paint it serves to fireproof wood and also to make paper and cloth fire resistant.

In recent years the discovery that many soils are deficient in boron and that this adversely effects growth of grasses and fruits and results in their susceptibility to disease (such as heart-rot in sugar beets) has resulted in the use of small amounts of boron in fertilizer mixtures. This may result in a considerable extension of the market for borax.

The saline deposits of southeastern California are capable of supplying the United States with borax at the present rate of demand for a long time, even from the presently worked deposits. A very conservative estimate would probably not place it much below a one hundred years supply. Moreover, very extensive deposits of colemanite which are not worked because they cannot compete with the richer sources now being exploited are known to exist in southeastern California and adjacent portions of Nevada. The picture of boron production is not likely to change greatly in the near future.

The importance of potash as a fertilizer has been emphasized so often that no discussion is needed here. For a decade or so following the First World War the Searles Lake deposit was the only important United States producer. However, the continued development of the New Mexican deposits of potash has resulted in their furnishing a larger and larger proportion of the total United States production and they now supply about 80 per cent of the total. But the Searles Lake production is very large and is capable of tremendous expansion. Potash is no longer a mineral in which the United States is deficient, and with the revival of world trade the potash from Searles Lake may be a major source of export. It enjoys an especially strong position in the Pacific trade.

The Searles Lake deposit is the major American producer of lithium compounds and, since the United States produces over half the world total, is the principal world producer. Recent years have seen a rapid increase in lithium consumption. Very little lithium is sold on the open market. One of the principal uses is in air conditioning. A saturated solution of lithium chloride can be used for drying air and removing odors. Another important consumer is the glass industry. Lithium assists in the processes of glass making and also produces certain special types of glasses. The third major use is in the enameling of various types of ceramic ware. The list of uses for lithium is long, but the other uses take only minor amounts.

All the other products of the California salines are only minor sources of the total supply of those minerals or chemical compounds. The chemical industry, minor salines in other parts of the country, or specialized chemical processes furnish the preponderance of the supply. These minor products are in direct competition with by-product supplies from those chemical industries which use large amounts of salt in their processes. However, these minor supplies produced by the California salines because of their importance to western industry have a greater importance than their share of the total national production would suggest.

With the possibility that China may become an unreliable source of supply for tungsten the plans to produce tungsten at Searles Lake take on added importance.

Numerous major trends in the world mineral situation are well exemplified by these salines. The enormous increase

in production that has been true of most world minerals in the last half century has been especially notable here. From the end of the first World War the consumption of these salt products increased by leaps and bounds until the beginning of the great depression of the 1930's. Then consumption slumped somewhat in the carbonates, but sales of boron products continued to increase. The enormous increase in use of borates came as a result of the lowered prices which followed the beginning of exploitation of the Searles Lake and especially the Kramer borate beds with their much lower production costs.

Another characteristic mineral trend is the tendency toward concentrated ownership of the commercial sources for the products. For the past half century borate production has been entirely in the hands of two or three firms. This has been true despite major shifts in the source of supply. Potash production in the United States has been limited to the operations of only a handful of companies. Moreover, for many years Searles Lake, the principal American source, was under control of the European potash cartel.

The third major trend is the tendency for the highest grade, low cost deposits to drive all other sources of the product out of production. Very large, high grade deposits of colemanite are known to exist and were exploited for a long period elsewhere in California and in southern Nevada. Though there is a sporadic, small production from these mines they represent an infinitesimal portion of borate production. Other lower grade deposits of borax exist in Chile, Argentina, Italy, and Turkey, but except for the Italian deposits they all have small production totals. Argentina has produced about 10,000 tons per year and recently Chile has had production of a few hundred tons.

What of the future? The three major sources of supply in the Mojave are so large, the deposits are of such exceptional richness, and costs of production are so low, it seems certain that for decades they will continue to be major producers of natural sodium and borate compounds, potash and lithium, and possibly tungsten. The reserves are so large that exhaustion at anything like present rates of production is something to consider only for the rather remote future.

No definite answer can be given to the question of locating other deposits similar to those now being exploited. The Mojave and adjacent portions of Nevada contain scores of basins superficially rather similar to those now being exploited. On the other hand, we have noted that in each of the cases certain highly unusual sequences of geologic events have taken place. It is highly unlikely that such unusual geological circumstances should have repeated themselves in very many places. However, other combinations of geological events of a type not yet discovered may have caused the deposition of other deposits. Two other circumstances bear on the possibilities. Methods for the location of other underground beds of salts, such as geophysical methods, are not very well developed. Drilling is the primary method. This is an expensive and rather haphazard method of prospecting for such deposits. Moreover, even though large undiscovered salt deposits exist, they may very likely have a small areal extent. The main deposit at Kramer despite its enormous tonnage is less than a square mile in areal extent. The situation may be summarized by saying that there is a

good possibility that other major deposits may be discovered but that we should look forward to their discovery hopefully rather than optimistically.

In the meantime we may confidently look to the present giant natural storehouses of chemical minerals in southeastern California to supply our industries, homes, and farms with these lesser known but vitally important products.

ACKNOWLEDGMENTS

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EMIGRATION TO BRITISH EAST AND CENTRAL AFRICA

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IN recent years the prospect of large-scale emigration from Great Britain has engaged the attention of economists and geographers. It has become clear that the Dominions could easily absorb any number of persons who are likely to leave the United Kingdom in the next two or three decades. Those countries have room for more people, their climates for the most part are suitable for Europeans, and they have administrations and social services which could be expanded rapidly to meet the needs of larger populations. So clamorous are some of the Dominions in their demands for immigrants that the opportunities for White settlement in other parts of the Commonwealth are easily overlooked. In Africa there are large areas of British colonial territory apparently suitable for permanent White settlement, and while these areas present the immigrant with difficulties of economic, social, and physical adaptation not encountered in higher latitudes, there are political, economic, and strategic reasons why they should be discussed in connection with emigration policies. The object of this paper is to examine some of the geographical considerations concerning economic development by White settlement in the British African colonies.*

Opinion is divided on whether Europeans are morally justified in acquiring freehold or leasehold rights to land in inhabited tropical and equatorial areas. This is an ethical consideration with which the geographer as such is not qualified to deal. Small White communities are in existence within the tropics. They were encouraged by British governments in the past, and present and future governments are committed to them. Some are vigorous growths which show signs of maturing into larger and better balanced societies. Others have an insecure foothold and seem likely to survive only so long as they can retain control of some branch of plantation agriculture. The practical issue is whether on economic or other grounds further development of these White communities is desirable.

Problems of the White Settler in the Tropics

Within the tropics only the highlands are likely to become important areas for White colonization, and even there the existing settlements have not been established long enough for it to be certain that European populations can thrive and multiply over an indefinite period. Much emphasis has been placed on the effects of altitude on nervous conditions, and on the acceleration of growth which causes some individuals to mature and to reach a physical decline earlier in life than they would in temperate latitudes. On the other hand, in Kenya, individuals of the third

*The term "Colony" is used throughout this article for any British area administered under the Colonial Office.

generation of descendants of the early White settlers show no obvious sign of physical or mental degeneration. Physical adaptation is a question on which medical science will have the last word, but the indications are that from the physiological viewpoint permanent and flourishing White communities are practicable in tropical and equatorial lands at altitudes of over 3500 feet. Condi-

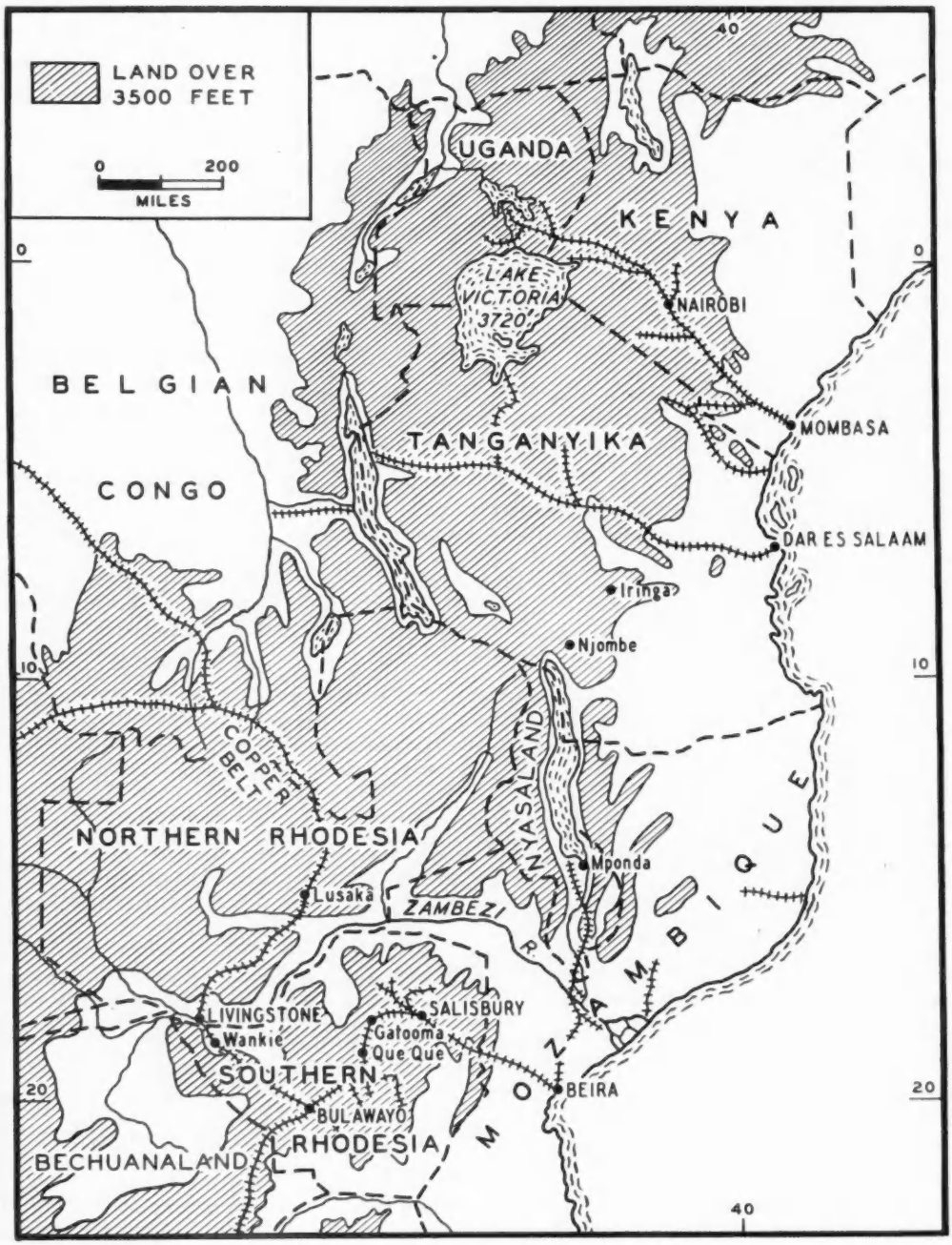

FIG. 1. Location map. British East and Central Africa.

tions are best between 3500 feet and 6000 feet except within three or four degrees of the equator where the lower limit is about 4000 feet. At higher altitudes the benefits of progressively lower temperatures are offset, in part at least, by the effects of rarefied air. It is an important fact that the recent war did much to destroy the prejudices widely held in Britain about living conditions in tropical and equatorial areas. Thousands of British men and women in the younger age groups had experience of conditions overseas and they saw at first hand how settlers in the highland areas live.

It is generally accepted that the northern European is not physically suited to undertake heavy manual work within the tropics. Under existing farming conditions he is dependent on colored labor even in highland areas. Overhead expenses in European enterprises are usually heavy, and in many Colonies competition from small native producers is expected to increase as the native peasant farmer becomes a more efficient cultivator. If the White farmers are to prosper without artificial protection they must produce crops at low prices. They must also become less dependent on native workmen, especially in parts of eastern and central Africa where the supply of colored labor is not sufficient to meet the increasing demands of industry and agriculture. Tea, coffee, and sisal, all of which are grown at appropriate altitudes in the inter-tropical highlands, will continue to require cheap native labor because they cannot be cultivated and harvested by agricultural machinery. Wheat and maize are also grown in parts of the highland areas, and where these crops are produced in combination with dairying and the raising of beef cattle, on farms owned and staffed by Europeans, it is practicable to apply agricultural machinery to an extent sufficient to make cheap labor unnecessary. Given a reasonably high material standard of living, the northern European can undertake the lighter manual work of a mechanized agriculture on high ground within the tropics without impairing his health. And the growing White populations of the towns of the Rhodesias indicate that he can also adapt himself to industrial employment in urban communities in those areas.

AN EXAMPLE FROM CEYLON

There are important relationships between the agricultural and land tenure systems on the one hand and the form of European settlement and society on the other. Where crops are grown in a system of plantation agriculture based on colored labor and large capital investment, and where the land is held not by individual planters or farmers but by commercial companies, the European society consists almost entirely of estate managers and their families. Societies of this kind are not greatly developed in Africa. The most compact example of the type found anywhere is the European community of the tea-growing country in the highlands of Ceylon. There, a White population of not more than 3000 is scattered thinly over the 1200 square miles of the island which lie between 3500 feet and 7000 feet.

Throughout this area in Ceylon the White planter is distinctly a visitor. There are a few native towns but none of these has a considerable European population, nor do they provide many facilities for the White planters. Such facilities as there are for social and cultural life are provided by the planters' clubs. These clubs are groups of buildings, often with golf courses attached, located among the plantations and usually well away from the towns

Their atmosphere is characteristic of the superficiality of the European's existence in a system of plantation agriculture, and they could hardly become foundations of a stable White society. In general the planters do not regard themselves as permanent settlers. In prewar days they normally intended to stay 20 or at most 30 years with occasional leaves in England during that time, and ultimately to retire in the home country. More recently the heavy taxation in England has caused many of them to consider seriously the possibility of retiring in Ceylon. But although there have been British planters in Ceylon since the early nineteenth century there is still no proper provision there for the education of European children. In view of the small extent of the highland area, and the lack of mineral and power resources which could form the basis of a numerically larger and less dispersed White settlement than that supported by the tea plantations, it seems that this small European community has evolved to a stage which offers no possibility of further growth.

Whatever the economic advantages of this kind of European settlement, there is little to recommend it socially as a form of colonial development. Even the outlook for its economic advantages becomes uncertain when, as in Ceylon, the cheap labor essential to its prosperity shows signs of becoming politically organized. It is highly probable that the plantation system will have difficulty in adapting itself to the new political conditions which are maturing in Ceylon and southeast Asia, and that a large and increasing proportion of the commercial agricultural production of those areas will be taken over by native peasant farmers.

SITUATION IN BRITISH EAST AND CENTRAL AFRICA

It seems that permanent European rural populations can best develop where, as in Kenya and the Rhodesias, land can be acquired freehold or on long lease by individual farmers. Societies based on this form of tenure grow to include a greater range of occupations than is found in plantation communities; they become deeply rooted and their members are concerned for the economic and political future of their Colonies.

In tropical and equatorial Africa there are five Colonies forming a continuous expanse under British control with extensive areas of high ground—Kenya, Tanganyika, Nyasaland, Northern Rhodesia, and Southern Rhodesia.

Kenya has about 60,000 square miles of ground over 4000 feet in altitude. The lower northern and northeastern part, together with parts of the Masai country in the south and southeast, has a small rainfall and is thinly populated by pastoral tribes. Some of it could probably be made suitable for stock raising on the pattern of Argentina if the natural grasses could be improved and if the few sources of surface water could be supplemented by underground supplies, but this will not be an economic proposition until the new methods of controlling insect-borne diseases are perfected. The central part of the area receives a higher rainfall, and at altitudes up to 8000 feet farms have been established by White settlers. Most of the 29,500 Europeans in the colony live in the highlands.[1] The number of European registered landholders is about 2000. There is also some White urban settlement; Nairobi, with a total population of 54,579, has 10,830 European inhabitants.

In Kenya, limitations on the growth

of the European population are imposed by two factors. In the first place there cannot be much more urban development because there are very few minerals and no local supplies of fuel for industrial use. Secondly, the extension of rural settlement is hindered by an acute land problem. Of the land over 4000 feet a large area has been reserved for native settlement. Only 17,000 square miles are reserved for European farmers, and about a quarter of that will probably be kept under forest. In the better parts of the native reserves adjoining the European highlands the density of the colored population exceeds 100 persons to the square mile, and in a few districts it is over 500 to the square mile. The native African farmers, trying to raise enough food by a system of bush fallowing, are exerting a great strain on their land. Over large areas soil erosion has reached an advanced stage and the crop yields are falling. In these circumstances any further European settlement must be confined to the 17,000 square miles set aside for the purpose. Of that area, which also has a large African population, it is reported that only about 2000 square miles are suitable for farming by European methods and that 70 per cent of this 2000 square miles is already occupied.[2] The optimum size of a European holding varies with local conditions of rainfall and altitude. Stock farms in the drier areas must extend to several thousand acres, while in mixed farming areas 300 to 400 acres might be an economic size. If 700 acres is taken as the average size there appears to be room only for about 600 new farms. Additional ground for new holdings could be provided by subdividing existing large estates.

In the mandated territory of Tanganyika uncertainty about the political future has discouraged capital investment, and White settlement has made little progress since the country was acquired from Germany. In 1948 the European population was 10,648. About 200,000 square miles, or over half the area of the country, is above 3500 feet in altitude. Two-thirds of the country, including much of the higher ground, is reported to be uninhabited on account of tsetse fly and lack of surface water; and the overall density of population in 1948 was estimated at 21 persons to the square mile. No estimate has been published of how much land could be developed for European agricultural settlement. Over much of the plateau the annual rainfall is sufficient only for stock raising, but in the south, in the isolated Iringa and Njombe highlands, there are some 14,000 square miles of very thinly populated country between 5000 feet and 8000 feet which receive a mean annual rainfall of over 40 inches. Opportunities for urban settlement are difficult to assess. Lead is known to be plentiful in the Mpanda area, but the mineral resources are mostly unsurveyed. Fuel is scarce. Water power reserves are small. In southern and central Africa the coal-bearing Karroo rocks decrease in thickness northward. In the Zambezi valley the coal seams are thinner and fewer than in Natal, and they appear to fade out completely in southern Tanganyika.

The small Colony of Nyasaland had a European population of 2500 in 1947. The over-all density of the African population in the protectorate was estimated at 55 persons per square mile in 1948, and it is probable that the agricultural land will be sufficient only for the needs of the expanding native population. The mineral resources have not been surveyed.

In the Rhodesias opportunities for European settlement are vastly greater than in the other Colonies. The com-

bined area of Northern Rhodesia and Southern Rhodesia is 440,000 square miles and well over half of this area is above 3500 feet. Of the total European population of 134,000, 80 per cent is in Southern Rhodesia. The towns of Bulawayo and Salisbury have White populations of 21,000 and 17,000 respectively. There are four other towns in Southern Rhodesia with European populations between 1000 and 3000. In the northern Colony the main White urban settlements are in the towns of the Copper Belt and at Lusaka and Livingstone. The political vigor of these Europeans is reflected in the recent discussions between representatives of the two Rhodesias and Nyasaland on the scheme for bringing together the three territories to form a Central African Federation with Dominion status.

European agriculture is at present largely confined to a belt of country about 100 miles wide along the main railway tracks. Away from the railways there are large areas of cultivable land which could be made suitable for European agriculture by the improvement of communications and water supplies and by the control of insect-borne diseases. Southern Rhodesia alone has over 50,000 square miles of unassigned Crown Land for sale; while in Northern Rhodesia, where climatic conditions are not quite so favorable for agriculture, an even greater area could be made available. The mineral resources of the two Colonies are supporting flourishing industries. The coal mines of Wankie, the scattered gold mines, and the industries of the Copper Belt are well known. Examples of more recent industrial growths are the coke ovens and by-products plant of Wankie, the iron and steel works of Que Que where production started in May 1948, the textile mills of Gatooma, and the small machine-tool industry of Salisbury. This colonial area of central Africa is unique among the inter-tropical highlands of the Commonwealth in possessing the basic requirements essential for a balanced agricultural and industrial economy and therefore for the growth of large rural and urban White populations. Such a development could take place without interference with the legitimate aspirations of the native Africans; for the average density of the colored population is low, about 12 persons per square mile in Southern Rhodesia and probably slightly less in Northern Rhodesia.

Economic limits to the growth of European settlement in the Rhodesias would be determined by the size of the African market for Que Que steel and other local industrial products, and by the local and overseas markets for the products of the farming areas. The collieries at Wankie, where the pit-head price of coal is less than ten shillings a ton, are at present capable of producing only 2,000,000 tons of high grade coal a year. This output is not sufficient to meet all the Rhodesian demands for solid fuel, and in 1947 it was necessary to import coal from the United States by the 1200-mile Benguella route through Lobito Bay. The annual production of the Wankie collieries is shortly to be raised to 5,000,000 tons, and there are at least six other coalfields in the Zambezi valley awaiting detailed survey and exploitation. The latest published figures relating to a full year show that 16,418 immigrants entered Southern Rhodesia in 1948; 7488 were persons with assured employment and the remainder mostly dependents. Of the 7488, 37 per cent were to be employed in public service, 28 per cent in manufacturing industries, 10 per cent in transport and communications, 9 per cent in commerce, and only 7 per cent

in agriculture. Comparative figures for 1946 were: total number of immigrants, 9000; 4312 with assured employment; 25 per cent to be employed in public service, 20 per cent in manufacturing industries, 7.5 per cent in transport and communications, 16 per cent in commerce, and only 12 per cent in agriculture.[3] These figures indicate that about 80 per cent of the immigrants intended to take up urban occupations, and they emphasize the overwhelming importance of European urban settlement over rural settlement in the economic development of this inter-tropical area.

STRATEGIC CONSIDERATIONS

From economic considerations alone it seems that while the inter-tropical highlands of the African Colonies, and especially those of the Rhodesias, should be regarded as areas which could absorb more European settlers, they are likely to be of secondary importance in Commonwealth migration policies as long as more favorable lands in temperate latitudes remain to be developed.

In assessing the full importance of the highlands it is necessary to take into account their newly acquired strategic value. Before 1939 the defense of the Commonwealth depended on the intensive fortification of a few small areas, many of them islands or promontories like Gibraltar, Malta, Aden, Singapore, and Hong Kong. Even the military base in Egypt was confined to the small area of the Canal Zone and the localities of Cairo and Alexandria. The experience of the 1939–1945 war proved that it is no longer safe to rely on these congested strongholds. The strategic base of today needs an area large enough for the effective dispersal of armed forces. Its agricultural areas should supply sufficient food for its civil and military population and it should have both heavy and light industries, well dispersed, for the maintenance of mechanized forces so that sea transport can be reduced to a minimum during hostilities. The withdrawal of British forces from Egypt has made necessary a new strategic base somewhere in eastern or central Africa. It has been popularly reported that Kenya has been selected for that purpose. Kenya might be large enough in area, and it has the advantage of proximity to the Middle East, but it lacks fuel and essential mineral resources. It follows that if the strategic potentialities of this part of the Commonwealth are to be realized in full, the agriculture and manufacturing industries of the Rhodesias should be expanded and adequate road or rail communications leading northeastward through Tanganyika to Kenya should be built. A large and permanent White population, forming both rural agricultural and urban industrial communities, is an urgent necessity in the inter-tropical highlands of eastern and central Africa if a rapid development along these lines is to take place, but the establishment of such a population would call for a new and more liberal interpretation of the colonial policy of trusteeship sufficient to allow for the necessary immigration and capital investment.

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"HIGH FARMING" IN THE EAST MIDLANDS AND EAST ANGLIA, 1840–1880

G. E. Fussell

This is the concluding article of a series by Mr. Fussell dealing with "High Farming" in England in the 1840 to 1880 period. The three earlier articles dealt successively with Southwestern England, January, 1948, Northern England, October, 1948, and the West Midland Counties, July, 1949.

Nottingham

IT was on the light lands in the Forest of Sherwood that the great improvements of the first half of the nineteenth century were made. These were the orthodox methods that had spread from Norfolk in the eighteenth century to the Lothians and Northumberland by the turn of that century and to the neighboring county of Lincoln at the same time as in Nottingham. So John Parkinson, of Layfields, who occupied some 1600 acres, proudly believed that Nottinghamshire light land farming equalled the excellence of famous Northumberland by 1860.[1] Corringham[2] expressed the same opinion in 1845, and it was only when the disastrous weather of the late 1870's interfered with the placid processes of the sheep and arable husbandry that this part of the county began to decline.[3]

The Duke of Portland by example and precept had fostered these improvements and from a rabbit warren and sheep walk worth only 2 shillings an acre much of the land had been brought under the 4 or 5-course rotation and a large area at Clipstone made into water meadow by diverting the river Maun into carrier drains. By 1845 swedes had been introduced by Colonel Mellish of Blyth who sowed them in drills and sliced them by machine. This soil was worked by scarifier for turnips and plowed, being dunged at ten to fifteen loads an acre. The Northumberland combined drill was used for sowing bone or rape dust and the large Suffolk drill for turnips. A good seeds mixture of 1 pound white or Dutch clover, 2 pounds of rib grass, 2 pounds of trefoil, 2 pecks of dwarf rye grass was used for summer pasture, but 12 pounds of red clover with one-half peck of rye grass only was used for hay. Yields were much higher than the national average being 30 to 40 bushels of wheat and 36 or more of barley; oats were only occasionally grown but peas sometimes took the place of clover. Vetches were grown for soiling horses, which were Lincolns and Shires with some Clevelands, and even in 1845 some steam engines were used for driving chaff cutters and threshers.

The cattle fed were Improved Durhams crossed again with the best Shorthorn bulls. A good landlord like Foljambe kept good class bulls for the use of his tenants free of charge. The sheep were improved Leicesters and Lincolns, a few Southdowns and Shropshire being found at a later date. The new artificials were used, bones on turnips, rape cake and guano. Nitrate of soda had been tried but discontinued, but shoddy was in great demand in

1845. Lime applied once in 10 years at 5 to 6 tons an acre was not so much used as in the past.

The methods of light land farming in the county did not change during the forty years until the losses of the 70's caused the farmers to keep their seeds down for two or even three years, to grow too many potatoes for sale to the growing industrial towns of Yorkshire and to Gainsborough, which brought in cash but did not permit the sheep fold. Foljambe[4] heartily disapproved of this on his estate. He was a great believer in the "golden hoof" on this soil for consolidation and for manuring. Some market gardening near the populous districts had a fluctuating career. When industry was prosperous the urban population bought vegetables and salad freely at good prices, but in hard times the crops could not be disposed of and so it was highly speculative.

Such evidence as there is confirms the three citations. Five other men beside Parkinson gave evidence to the *Select Committee on Agricultural Customs 1848*, and though they do not claim to have played so large a part in conducting and stimulating improvements as he did, they confirm his findings. They were Edward Woollet Wilmot of Etwall, where he had lived since 1827; Richard Chowner, President of Burton on Trent Farmers' Club; Charles Stokes, who farmed 420 acres in South Nottingham; John Jephson Rowley near Mansfield; and Geo: ge German, a farmer and land agent in Derby near the borders of Leicester and Warwick.

Fig. 1. Agricultural improvement. (Reproduced from G. H. Andrews, "Modern Husbandry," 1853.)

W. L. Rham and J. C. Morton[5] found the old heavy land rotation of fallow, wheat, beans and peas, oats was still practiced on the heavy clay lands of the western part of the county, but by the 1850's the cultivation was better and the yields larger. A few hops and a tiny acreage of market gardens to provide the large towns

had been started. Caird[6] reported that the fallow was abandoned here, but Rham thought many farmers considered it essential. There were a few small dairy farms on the bank of the Trent where the meadows were excellent. These had produced a cheese known as the Trent Bank cheese, but by the time Foljambe gave his evidence the liquid milk was being sent to Yorkshire towns and to Gainsborough.

An interesting point about the arable-sheep farms reclaimed from the forest is the tiny area of permanent grass kept up on them. Enoch Hodgkinson of Morton Grange farmed 759 acres only 30 of which was permanent grass. T. Wilkinson of Ranby Green Mile had 550 acres but only 20 grass. Ashton of Hodsoak was about the same, but he had 100 acres of grass and 376 acres of arable.[7] John Hemsley of Shelton, Newark, so late as 1875, thought that the country with a dry climate and light soil was more adapted for grain-growing than grazing and that laying down to grass was a retrograde step. If it was done in the county the landlord would have to help because there would be no profit for three or four years after, but John Brett who held 454 acres at Acton Grange, Southwell, on a year-to-year tenancy, had by then seeded down several pieces of heavy clay that did not pay for cultivation, a reasonable enough thing to do then.[8]

Such high farming as there was in Nottinghamshire had been well in hand before 1840. The forest was being enclosed, reclaimed, and laid out in largish farms up to 500 acres during the first 50 years of the century and the work had been so far advanced by 1860 that Parkinson was then able to maintain the county's claim to rank with Northumberland in English farming. Good implements were used, the livestock was of the best sorts and well kept on the new concentrates and green crops, the new artificials were used, and some draining had been done in the clay. The dairies there were ceasing to manufacture cheese because an accessible demand for liquid milk was arising.

LINCOLNSHIRE

The story of Lincolnshire farming during this period is much the same as that of Nottingham. The cattle, horses, and sheep of the county had always been recognized. Already by the accession of Queen Victoria, the "Turnills" bred by Captain Turnill of Reesby were renowned and a Durham cross had given the native breed a disposition to fatten readily. Mr. Shields of Fordston was feeding for a better grain in the meat. Already by 1843 Philip Pusey could find miles of Lincoln Heath reclaimed from the waste in the previous half century. He describes fields of turnips without a blank or a weed, thousands of long-wooled sheep in netted folds, every stubble field clean and bright, and every farmhouse well-built—a kingdom made out of bleak downs, a furze-grown rabbit warren, but then farmed equal to the best of Northumberland. Much of the fen also had been drained and more was being done. The rural population there was actually on the increase at a time when it was dwindling elsewhere, but some of the heavy land was not so well farmed. Lincolnshire cattle, sheep, and horses were always famous. Clarke repeated Pusey's enthusiastic remarks about the county in 1878.[9] Lincolnshire Heath, Wolds, and Cliff were patterns of the high farming of which so much notice has been taken; in the lower lands some farms were small and round Wisbech the modern development of flowers, fruit, and vegetable growing was in its infancy by 1880.

Leicestershire

Though Leicestershire was always largely a grazing county, it had equally been capable of bearing good wheat and hay, crops of beans. In the west of the county green crops, turnips, swedes, rape, and cabbage were grown by 1848 although the ley was left down for two years. The new manures were also freely used here. Stilton cheese was made in the north and east from the produce of Longhorn or Shorthorn cows or a cross between the breeds. Each cow was expected to yield 4 cwt. of cheese a year and to require for her keep summer and winter 3 acres of land. Pigs were kept on the dairy waste products and sheep were fed with the cows on the pastures. The new Leicester sheep, developed by Bakewell in the eighteenth century, were common all over the county. Good horses for the farm, the cart, and the saddle were bred.

Less than twenty years later the farming of the county had so far been modified that it had taken on its modern form. Where grazing was the employment, extra cattle were bought in to meet a flush of grass on the rich pastures and cake was brought to meet a failure of the grass. Welsh and Scots runts were used to "grow off" the rough coarse patches. The fields were grazed and mown for hay in alternate years. Much of the stock was bought in for summer grazing and sold off in the later half of the year. The sheep were bought in September and October and sold fat in May, June, or July, being drafted weekly. A few horses were bought as colts in the autumn and sold the following autumn.

The breeding farms grew straw and roots, and cake feeding was necessary if the stock was fattened off. Small areas of these farms were under a 6-course rotation. Naturally there was always a tendency to change from the plow to grass in a county so peculiarly well suited to that business as Leicester, and this was accentuated by 1875. The pastures, always approved of, were the subject of unrestrained enthusiasm a few years later. The county's large proportion of grassland has made it famous for fox-hunting.

Bakewell made history in Leicester in the eighteenth century. It is doubtful whether he was surpassed by any single person in the nineteenth century. Clearly the farmers were adapting their system to modern needs during the period 1840 to 1880, despite the heavy losses of livestock they suffered from in the late seventies. Cattle fell from 136,848 in 1875 to 123,681 in 1881, a decline of 10 per cent, while sheep declined from 453,477 to 263,383 in the same few years, an appalling blow to people so dependent upon their animals for their livelihood.[10]

Rutland

The smallest county in England was closely allied to Leicester in the form of its agriculture. On the banks of the River Welland there were excellent meadows similar to those of Leicestershire. On these choice animals were reared in 1850. They were pure Shorthorns, the Longhorn having been outmoded by them. Some Devon, Hereford, and Scotch animals were bought for finishing. It was estimated that on these good pastures some 40 to 50 stone of meat per beast was produced.

The sheep were predominantly New Leicester, as might be expected, but there were a few Southdowns. On a few farms the turnips were sliced by turnip cutters before being given to the sheep, and Rham thought this an improvement on feeding whole roots.

The horses were not carefully bred.

Some were worked one or two years and then sold to the London draymen. Three horses were used in the plow on land where Rham considered two would have sufficed. The county had its own plow, the Rutland plow with two unequal wheels. On the light land the 4-course rotation, including a crop of peas, was usual; the heavy land was cropped with oats and beans instead of barley and peas, and a bare fallow was the common practice.

This describes the farming in 1850 pretty well, and Caird adds nothing to it, merely commenting that the grass was good, the turnip culture poor, but the wheat yield had risen since the days of Arthur Young from 20 bushels an acre then to 28 in 1850.[11]

The county continued gently in its chosen way much as Leicestershire did at least until 1882 when Druce reported to the Richmond Commission. The 4-course rotation was still usual then and the leases forbade the growing of two white crops in succession. The farming of the county was much like that of its larger neighbors, Leicestershire and Lincolnshire.

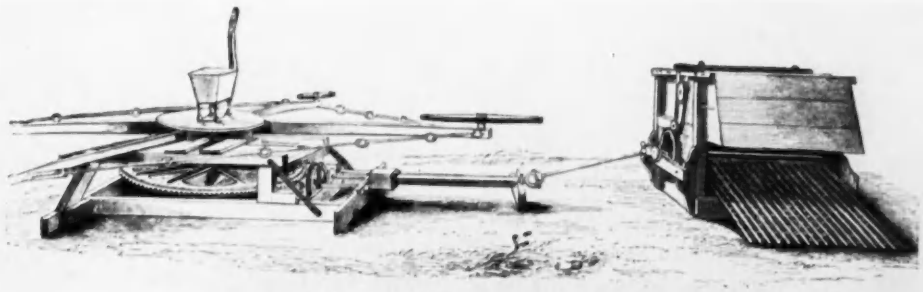
The livestock, except pigs, had suffered the usual diminution owing to the bad seasons and the consequent disease. The decline is measured by the official returns as:

	1875	*1880*	*1881*
Horses	3,157	3,190	3,103
Cattle	17,715	17,356	17,355
Sheep	105,697	95,680	80,252
Pigs	3,219	3,254	3,470

NORTHAMPTON

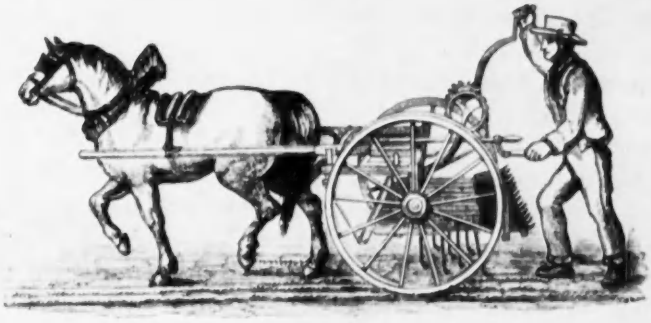
In 1880 Northampton was classified as a grain and pasture county by the compilers of *Agricultural Statistics*. The county had long been famous for breeding black horses that were worked a few years and then sold to London for coach horses and it had bred quantities of cattle and sheep. Its farming was described at some length by C. Hillyard of Thorpelands near Northampton in 1834 in a little book he wrote for the guidance of his son.[12] Hillyard had formed his opinions on practical experience and the inspection of well-managed farms. Books about farming he had given up reading thirty years before because he found them so verbose and theoretical. He advised his son to distrust experiments and to follow the best management in his district.

Hillyard's farm was a turnip soil, loam and sandy loam, and, if he did what he advised should be done, he carted most of his turnips for eating by yard-fed cattle. He often left his ley down two years. The normal 4-course rotation was usual in his neighborhood on poor light lands, but on better soil the rotation was longer: turnips; barley; seeds; wheat; oats or wheat; peas; barley. Clay was cropped fallow; barley; clover; wheat; oats. The very strongest clay had an occasional crop of clover, but fallow was necessary, and the old wheat and bean course was not unusual. Hillyard did not think the poorest clay worth cultivating as the labor was great and the produce small. He foresaw the day when there would be a steam engine to plow a dozen farms at once. He noted that too many plows in the county were hauled by three horses at length when two abreast would have sufficed, but did not think the famous Norfolk plow fit for Northants. He praises drilling but did not like dibbing. He did not think potatoes, other than for home use, should be grown anywhere except near large towns. He was writing at a time of depression, and did not believe either grazing or stall feeding would ever be profitable again. He thought the best chance of success was winter grazing,



GARRETT'S THRESHING MACHINE AND HORSE GEAR.

GARRETT'S REAPING MACHINE.



HORSE HOE.

Fig. 2. Some types of farm machinery. (Reproduced from Samuel Copland, "Agriculture," 1866.)

and he ends with instructions for laying land down to grass.

He was wrong, as such depressing prophets happily so often are. By 1850 Rham[13] found cattle fattening one of the most important industries in the county, and estimates that of the 80,000 acres of pasture about half had been laid down in the previous 50 years. The great landowners were breeders, mainly of Shorthorns, stimulated by the work of the then late Lord Althrop of Wiseton, but the tenantry brought Scotch, Welsh, Hereford, and Durham stores for finishing. The sheep were the improved Leicesters and there were some fine breeding flocks. The arable land was cultivated as Hillyard describes.

Caird amplifies this. Mr. Sharpley of Wittering had 630 acres including 150 acres of grass. The arable land was farmed on a strict 4-course rotation and 100 acres of grazing were sown with 12 pounds of white clover, 2 pounds of trefoil, and one-half peck of rye grass per acre. For hay, 14 pounds of red clover and one-half peck of rye grass were sown. Sharpley had a flock of 1600 Lincoln ewes lambing in March, a few milch kine, 18 to 20 young heifers calved down. The steers were kept till three years old and then sold for finishing. Mr. West of Dallington sowed mustard for green manure. Mr. Shaw of Cotton End near Northampton sowed potatoes on seeds after eating off with sheep and also produced liquid milk which he retailed in the town. Mr. John Beasley of Chapel Brampton and Overstone was a famous breeder of Shorthorns and New Leicesters and farmed 720 acres, 425 acres of which was in the 4-course. He had drained the whole farm 3 to 4 feet deep with 9 inches of stones over tiles, plowed down the old high ridges, and subsoiled the land. He was agent for Earl Spencer (Lord Althorp), Mr. Lloyd, and Lord Overstone. South of Weedon land of prime feeding quality was not common but Caird was astonished to see plows hauled by 5 horses in a line, a needless waste of power.[14]

William Bearn, who wrote a prize essay on the county for the Royal Agricultural Society a couple of years later (Jour. 1852), remarks that two of the finest farms near Firedon in 1852 were waste overrun by furze in 1806, and that a wide area of this kind of land had been similarly reclaimed. The parishes of Kingsthorpe, Boughton, Brampton, Spralton and Creaton, Harlestone, Dallington, Dunston, Moulton, Pitsford, and the adjoining parishes, a district formerly capable only for growing rye, had been made into some of the most fertile and best farmed land in the county by introducing the 4-course rotation and keeping larger flocks. Other parishes where the same thing had been done were Abington, Weston, Billing, Ecton, and Earls Barton.

Fifteen years later there were steam plowing sets, prophesied by Hillyard a generation before, on four farms in the county: Tanholt Farm, Eye, Peterborough, of 300 acres arable and 100 acres grass; Overstone Grange, near Northampton, 375 acres arable, 100 acres grass; Manor Farm, Thrapston, 500 acres arable, 225 grass; Orlingbury, Wellingborough, 570 acres arable, 400 acres grass.[15]

No change in the general outline of Northamptonshire farming had taken place when Druce reported to the Richmond Commission in 1880. The 4-course rotation was usual on the arable land, the graziers were using the same breeds of cattle and sheep, the pigs were Berkshire, but by this time the light-legged English cart horses bred in the county were not, he said, so well regarded. Losses had been very heavy in the bad years.

	1875	1880	1881
Horses	19,829	21,998	21,871
Cattle	118,044	113,035	111,863
Sheep	553,112	457,412	404,654
Pigs	29,320	29,595	29,394

Progress had been made in the four decades. The light land had been improved by using the arable-sheep husbandry, but then Northampton had been one of the earliest counties to adopt clover and turnips[16] and though Bearn claimed that this had been done over so wide an area this work was done before 1852. The county may rightly be named as one where high farming was fairly general, but just how general it is very difficult to say.

Bedford

Bedford was classed as a mixed pastoral and corn county when Druce reported on it in 1882; it was the county where the Duke of Bedford, friend of Coke of Norfolk, had begun the famous Woburn Sheep Shearings in the eighteenth century, and had so influenced the whole progress of British farming. Nothing less could be expected than that it should be well farmed at the accession of Queen Victoria. Not only did the Dukes of Bedford have great estates there but the Rothschilds as well.

Francis, the seventh Duke of Bedford (1788–1861), was a friend of Lord Althorp, and carried on the fine traditions of his family for land improvement. He succeeded in 1839 and carried out a splendid system of drainage on the clay soils north of Bedford. Woburn Park Farm, which has since become Woburn Experimental Farm, was admirably managed, especially the turnip husbandry, and there was a splendid herd of Herefords and a magnificent flock of Southdowns.[17]

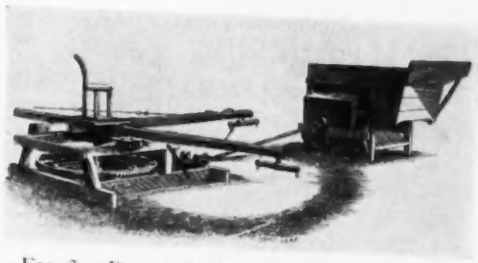


Fig. 3. Ransome's four-horse portable threshing-machine, fixed for work. (Reproduced from William and Hugh Raynbird, "Agriculture of Suffolk," 1849.)

William Bennett, who afterwards wrote an essay on the county, also gave evidence to the Select Committee on Agricultural Customs in 1848. He had occupied 3000 to 4000 acres for the previous 16 years and had greatly improved his own farm by artificial manures for turnips and wheat and high feeding of stock. He recalled that he had given evidence in 1836 and mentioned that when his father drained a farm of which he was tenant the rent had been raised from time to time until it was double what it was before draining, and the tenant had no compensation for his expenditure. He carried 500 sheep on 350 acres including 250 fatting ewes, to which some grain was fed. His enterprise was very large for the county where the majority of farms were about 200 acres, few being so large as 500 to 600 acres.

The Whitbread estates were not so well equipped as the Duke's in 1850. The buildings were very old-fashioned, of wood and thatch, but the rentals were moderate and the tenants not disturbed unless for very good reasons although they had no leases.

Thomas of Lidlington was another large scale farmer. He occupied 500 acres of heavy land on the 6-course: fallow with cake; seeds or tares dunged, the bare fallow limed; wheat; clover; oats; beans; wheat. His flock was 500 ewes, half pure New Leicesters, the rest

pure Southdowns, given grain, cake, and beans in winter. His herd was 80 two-year-old Devons or three-year-old Scots bought in spring or summer, run on grass, wintered well, given the best grass the following summer, and finished that autumn.[18]

William Bennett confirms all this in 1857, but adds that peas and beans were grown on the lighter soils when they were clover-sick. Bentall's broad-share was used on wheat stubble here for autumn turnips although Bennett considered mangolds a more certain crop. Fly and disease had affected turnip yields seriously in the previous two years. The horse hoe was generally used. On the chalk in the south of the county there were few turnips, but about one-eighth of the arable was sown with sainfoin, the venue of this crop being changed after one whole course of cropping on the rest of the farm. The eddish he considered a wholesome or forcing feed for lamb. Another practice here was to grow a crop of oats after the wheat, making the rotation 5-course. The cultivation of turnips was however improving of recent years with the aid of Lawes' turnip manure. The old Bedfordshire wooden plow had given place to Ransome's and Howard's (of Bedford) 2-wheel iron plow, and other improved plows had been then recently invented by Taylor, Mr. Williams, and Mr. Hensman. The iron harrow and steel tined horse drags were also in use; the Batchelor Steerage lever drill was used for grain, which was nearly all drilled, though beans and wheat were put in with a double dibble.

The livestock were ordinary. The horses were bought as colts but there were a few studs of Suffolks. The cattle were mainly Shorthorns, but the Duke and a few others, including Thomas of Lidlington, had Herefords. Few cattle were bred. The sheep were excellent New Leicesters, Southdowns, and Cotswold, and various crosses between them.[19]

Already by 1871 the market gardens round Biggleswade, Sandy, and the adjoining parishes were developing on small holdings there. The crops grown were varied but potatoes and onions were the main ones. Besides these grain, turnips, kohlrabi, a few carrots and parsnips, and a little onion seed were produced. Scarcely any peas and no "fancy crops," as flowers and culinary herbs, were indulged in. Heavy dressings of dung were the secret of fertility and some guano was bought. Cucumbers were cultivated and some lettuce. Mr. W. Pope of Biggleswade was one of the best known in this area.[20]

The prize winning farmers in 1874 demonstrated in their practice only an intensification or perfection of the systems already described. Richard Checkley, Brogborough, Woburn, won first prize. His farm was 336 acres arable and 292 acres grass; second was Thomas Crouch, Lidlington, 262 acres arable and 195 acres grass; others were Charles Howard, Biddenham, near Bedford, who worked three farms; Lilley, Knotting Green, near Sharnbook, 238 acres arable and 197 acres grass; Phillips, Brickmore, near Woburn, 220 acres each arable and grass; Street, Mouldon, Ampthill, 360 acres arable and 120 acres grass; Paine, Goldington, near Bedford, 293 acres arable and 29 acres grass.[21]

Druce in his report to the Richmond Commission of 1882 has nothing in the way of variant to add. The losses in cattle and sheep after 1875 are shown below:

	1875	*1880*
Horses	11,064	12,082
Cattle	34,285	31,552
Sheep	178,662	152,084
Pigs	27,781	28,526

Bedfordshire must be considered one of the counties where high farming was the rule, but most of the foundations of the systems had been laid before 1840. There is no possible measure of what improvements were made thereafter.

Huntingdon

A large part of Huntingdon was still in pasture in 1850 although a good deal of land had been broken up in the previous half century. The county was divided into the Fens in the northeast, the gravelly soils of the Ouse valley in the southeast, and the Oxford clay of the middle and west. Rham thought the fields were too large and would be drier if they were smaller and more ditches were cut. The cattle were Shorthorn, the sheep Leicesters, and the pigs Berkshires or Leicesters.[22]

Much of the heavy land was still undrained and the rotation practiced was not adapted to heavy wet land. Yields were low and returns with declining prices did not cover expenses; but Caird thought, like Rham, that drainage would solve the problem. Near Godmanchester and Huntingdon the 4-course rotation was not very successfully followed, the farmers were in poor case, and perhaps one-third of them would give up if prices fell any lower; others wanted rents reduced by 25 per cent.

Eykyne of Woodhurst had a good heavy land farm of 200 acres including 80 acres grass and got high yields: 32 to 36 bushels of wheat; 28, beans; 50, barley; whereas in 1813 yields were only 20 bushels of wheat, 30 to 35 bushels of barley and 30 to 40 bushels of oats. Eykyne had dropped the old rotation and developed a 6-course of fallow with 12 bushels bone dust, mustard in July plowed in for wheat; beans, barley with red clover dunged at 8 to 10 tons, the ley being part fed off with sheep and part mown; wheat. Crops were carefully hoed. Forty or fifty cattle were fattened in stalls in winter on hay plus 9 pounds oilcake and 3½ pounds of bean and barley meal, some 40 acres of fen hay being used. Three or four horses in line were necessary in a plow although the farm had been drained, but it was plowed 2 inches deeper than ordinary practice.[25]

All the fenland from Fen Stanton round the eastern edge of the county to Yaxley and Farcot was drained by open ditches and was mostly cultivated on the 4-course system in 1868, but it was too soft to allow the farmers to use the then novel reaping machines on their crops of 32 bushels wheat and 40 bushels barley, the average in a good year. Part of the root break was drawn for stall feeding cattle, and the rest folded by sheep which also got grain and cake. Clover was only grown when the land had been clayed, a process involving digging trenches to the clay and spreading the spoil on the surface. The yard fed cattle were sold again in spring to the graziers of Leicester and Northants who finished them. A good many Leicester and Lincoln sheep were bred and finished. Each farm here had a chaff-cutter and a bean-mill, 2-horse iron plows, all the then modern types of grubbers, etc. J. M. Heathcote of Conington Castle was a spirited improver and owned an estate of 3000 acres. W. Wells of Holme Wood House had 8000 acres.

The Oxford clay stretched from Sawtry to Diddington and from Pidley to Keyston an area of 120,000 acres. Variations on the 4-course were the rule: green crop; barley; beans or clover; wheat. Farm horses and hunters were bred, as were Shorthorn cattle. The sheep were mostly improved Lincolns. Pig breeding was a considerable indus-

try. A few reaping machines were in use here, but all over the county thrashing was done by contractors who used portable steam engines for power. Suffolk drills were almost universal, and Colman's cultivators were used in summer. Some twenty sets of steam cultivation tackle were in use in the county. Market gardening was carried on in a district running from Hemmingford to St. Neots and so to Eaton Socon, the produce being sent to London.[24]

Sainfoin was still held in good opinion in 1875. Peter Purvis of Brampton, Huntingdon, thought that it was excellent in long leys which were preferable to seeding down to permanent pasture. Sainfoin would keep for six years and throve admirably on the local soil yielding nearly double any other artificial grass. It was increasing rapidly especially on high ridges of poor land dividing Huntingdon from Bedford. Purvis had himself laid down some old arable with seeds for permanent pasture, but did not think any tenant could do that profitably as it takes a lifetime to make a good old pasture out of old arable land.[25]

The system of farming practiced in the county had not changed when Druce reported in 1882. The 4-course on the high fen soils and a suitable variation on the clay persisted. A good many sheep were bred but not many cattle, and both were fattened in considerable numbers, so no material change had taken place in the four decades, except that by draining the clays had been improved and yields increased. Good implements and machinery were fairly widespread. The new artificials and concentrates were used. The county was one of fairly intensive farming, but heavy suffering had been caused in the bad seasons by excessive and repeated floods. One man at Kimbolton had reduced the size of his holding and taken up specialized poultry breeding using the 4-course system to produce feed. The livestock position in these years was:

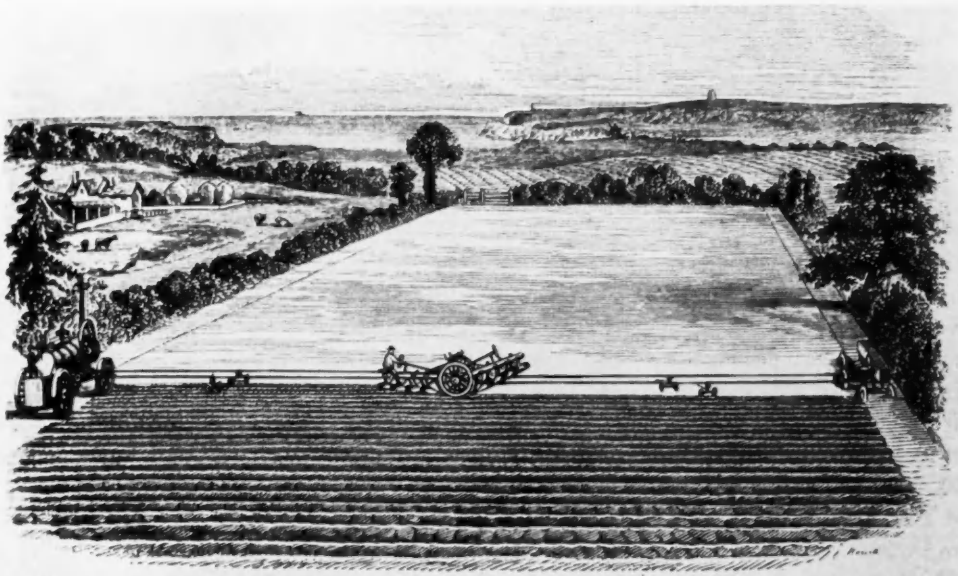
	1875	*1880*	*1881*
Horses	9,798	10,969	10,586
Cattle	26,301	28,313	27,020
Sheep	156,022	155,059	135,824
Pigs	18,801	17,475	17,272

CAMBRIDGE

As elsewhere in Eastern England great improvements had been effected in Cambridgeshire both in the Fens of the north and on the clays of the south before 1840, and the standard of farming set then was high.[26] Perhaps it had been intensified before the bad seasons of the 70's set in, but the farming certainly followed the same general principles of practice.

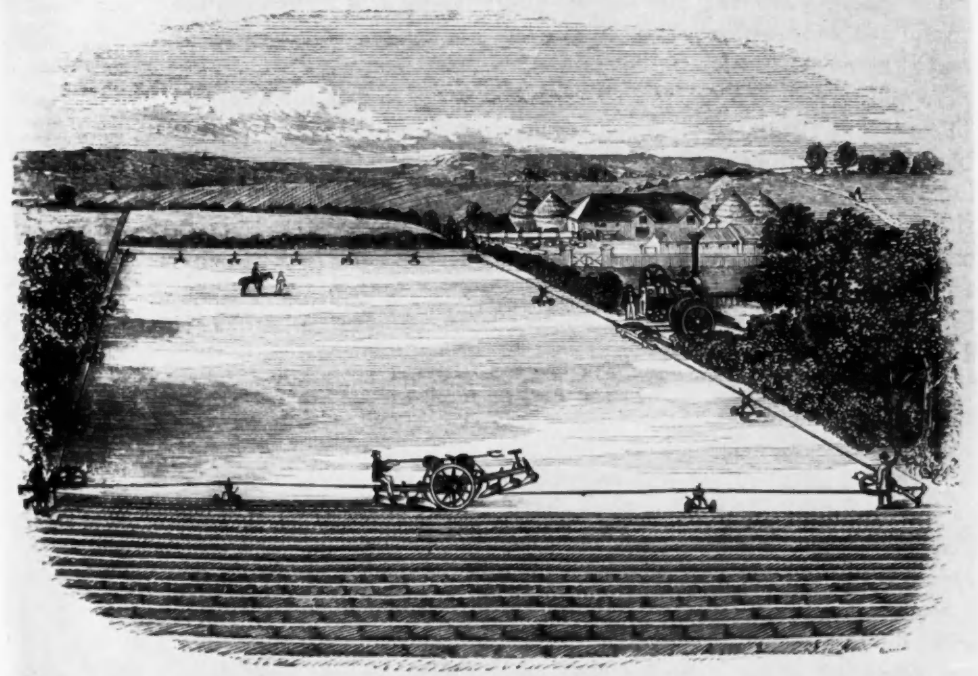
Samuel Jonas of Brabraham, himself one of the great improvers of the county, remarked in 1846 that a vast area of waste had been brought into cultivation by drainage of clay, draining and claying in the fens, and by improved rotations on high land. He divided the county into four districts. In the first from Royston and Ickleton north beyond Newmarket and the borders of Suffolk a 4-course was followed: fallow for turnip, rape, or mangels; barley; seeds; tares or peas; wheat or oats. The roots got burnt weeds mixed with guano or bones or dung. Bunching was done with a special harrow with only two rows of teeth, singling by hand hoeing, one-fourth of the crop was drawn for yard fed beasts, the rest being folded by sheep. The seeds were sown by drill or hand barrow. The cattle were Shorthorns, Herefords, and Devons, and a few Welsh runts or Galloway Polls.

The second division was on the east near Essex and Suffolk and was in



FOWLER'S STEAM PLOUGHING APPARATUS AS AT WORK.

In working, the Engine and Anchor move at each bout with the Plough throughout the field.—See p. 608.



HOWARD'S STEAM PLOUGHING APPARATUS AS AT WORK.

In working, the Engine and Windlass are stationary, and the Anchors are moved forward.—See p. 606.

Fig. 4. Two types of plowing apparatus. (Reproduced from Samuel Copland, "Agriculture," 1866.)

general heavy land all of which had been hollow drained. Here again a 4-course rotation was used the land being plowed in 8-foot stretches, the horses walking in the furrows when drilling. Few turnips were grown here.

The third was the most backward part of the county, in the west where the staple was thin and the land left in the old high ridges because the farmers were afraid of exposing the sterile sub-soil if they plowed the ridges down. Jonas thought it should be hollow drained and believed some could be made into good water meadows, some 300 acres of which he had constructed at Brabraham. There he had bred and improved Southdown sheep since 1823. He preferred them to some people's choice of Leicesters and Lincolns. Sainfoin was grown on the chalky soils as elsewhere in similar conditions, and made good wintering for horses and chaffing for sheep, the rowen (aftermath) being most valuable for lambs.

In the Isle of Ely, the fourth district, there was no regular system of cropping, but long rotations were usual, often including several white crops in succession. The plow was a light wooden one with a wide breast, very wide share, and a circular coulter, possibly derived from Holland some two centuries before. The wheat was drilled and good crops obtained. Few sheep were kept, the clover and rye grass being mown for hay and only the aftermath fed.[27]

A good deal of claying had been done in the fens here as in Huntingdon. A trench was cut 2 feet wide by 2 feet deep and the clay spread on the fallow 4 yards on either side, the trenches being 8 feet apart so that all the ground was covered. After draining, the top soil was sometimes pared off in strips with a paring plow, piled in small heaps and burnt, the ashes being spread as a preparation for cole or rape to be followed by oats, wheat or oats with seeds, and ley left down so long as good. These processes were common to all the fenland.[28] On the Duke of Bedford's estate at Thorney the rotation was fallow with roots or coleseed, oats, wheat, seeds, wheat, beans, wheat. The fallow was dunged with 8 to 10 loads per acre while for cole 16 bushels of bones mixed with ashes were given. Yields were very heavy for the day being 80 to 120 bushels of oats and 44 of wheat.[29]

Little alteration took place in these conditions. Herbert J. Little of Wisbech, who was the brother of one of the Assistant Commissioners on the Richmond Commission, farmed a holding comprising 440 acres of arable land and 220 acres of grass, which he had occupied for 11 years when he gave evidence in 1881. Before then he had farmed in Northampton. His rotation was normal. It was coleseed or rape; oats; wheat; seeds or beans or peas; wheat; and, if the land was in good condition, a crop of barley before beginning the round again. It was impossible to grow turnips here because they ran to neck, were subject to rot, and were of bad quality. His yields were high but had fallen off. From 1867 to 1874 he got 37½ bushels of wheat but from 1875 to 1880 only 30¾, which must, however, have been well above the national average then. He bought in and sold off about 100 bullocks and 600 sheep annually, Shorthorn beasts and Norfolk half bred (a cross between Leicesters and Lincoln) sheep. Many of the small farms in the district were in a bad way. Much damage had been done by spurious manures but both artificials and concentrates were widely used. He bought cake from a firm in Liverpool and from J. and R. Marriott of Kings Lynn, and used dissolved bone manure. He did not like steam

cultivation on his land, believing it was inclined to do damage, and so had practically given up by 1875, wholly by 1877.

Many farmers followed a 5-course system, but Druce told the commission in his Report that this was by compulsion of agreement or lease. Druce estimated that two-thirds of the county was fen and the rest mainly chalk and there is nothing in his Report to indicate that the systems of farming had been fundamentally changed since Jonas wrote his essay in 1846. As I have said they may have been intensified but in what measure, if any, it is now impossible to calculate. The bad years had seen the flocks reduced, but by a surprisingly low percentage. The small farmers had been obliged to sell off some of their pigs. Cattle had decreased by 1000, a little over 2 per cent. The figures are:

	1875	*1880*
Horses	25,959	29,387
Cattle	47,507	46,490
Sheep	321,993	309,250
Pigs	43,687	39,459

Norfolk

Because of the activities of two great landowners, the so-called "Turnip" Townshend and Coke of Holkham and the publicity which gathered round their work, Norfolk has always been in the forefront of advanced farming in England and was amongst the earliest in that position. Even when Arthur Young began his *Tours* in the late 1760's, there were great farmers in Norfolk who had already developed the renowned 4-course system.[30] A century later James Algernon Clarke could find only the same system, much more widespread it is true, for Coke's great work had been done in the interval, but the same system nevertheless.

The county is divided into several well defined physical sections. There is a large area of fens; there are the wild heaths and blowing sand round Thetford and Fakenham; there are the heavy lands in the south and center of the county; and there is the venue of the great improvements from Houghton to Holkham. The fens, much of which had been drained by 1840, was worked much like the adjoining county. The rotation was fallow or turnips or coleseed; wheat; beans or clover; wheat, or if the fallow had been bare, turnips; oats; wheat; beans; wheat. Of late years in 1847 a good deal of grassland had been broken up and here between Lynn and Wisbech if not too near the sea the land carried eight to twelve Devon and Leicester cross bred sheep and one steer to four acres. Potatoes were extensively grown. In Marshland Smeeth the bare fallow kept the land clean and no manure was applied. South of Marshland there was some grazing land and so was used the high land between Elm and Wisbech, some 8000 acres having been drained a few years before in Waldersley district. A little field drainage had also been done with good results; bone dust was always used here on the fallow crop.[31]

Rham found it necessary to remark that the Norfolk system had been improved upon in the North of England and the Lothians, many turnips still being broadcast in Norfolk at 1850; only the gentlemen and large farmers used drills. The best crop in the county was the barley sown on unplowed land after turnips folded with sheep. He admired the implements especially the light plow which Young had admired before him. The spiky roller was used for barley and threshing machines were common although some was still done with the flail to provide winter work. The old Norfolk sheep had vanished

before the superior claims of the Norfolk half-bred, and pure Southdowns and Leicesters were kept. There were a few dairies, but as ever numerous stores were fattened, Galloways, Aberdeen, old Highland, and Irish, but Polled Suffolks were kept to provide household milk. Some horse breeding was done and store pigs from Essex, Suffolk, and Berkshire were fed on the stubbles and waste barley. Turkeys, formerly driven on the "hoof," were sent to London by coach in 1850. Caird's report concentrates on the large farmers who used the new fertilizers, guano, nitrate of soda, and superphosphate. Norfolk never behind the times had adopted (it never in fact adhered strictly to the 4-course system)[32] the 5-course on the heavy rich soils and used beans as a preparation for barley. It differed from the 5-course of Northumberland in that the fifth crop was wheat and not oats as the colder climate and elevation in the north demanded. Occasionally peas were grown as an alternative to clover when the land had become clover sick.[33]

An outstanding example of what could be done in Norfolk was the enterprise of John Hudson, the Lodge Farm, Castle Acre, a holding of 997 acres. It had been refused by three other persons before he took it and another farm of 500 acres in 1822. The outgoing crop in 1822 was only 20 bushels of wheat an acre, 24 bushels of barley and roots for 10 beasts only. In 1847 the 4-course rotation was practiced, but in 1869 this had been changed to a 5-course. Large amounts of capital had been applied, £2000 to £2500 a year spent on oil cake, £800 to £1100 on artificial manures, so that it had become possible to overwinter 100 to 140 steers according to the yield of the root crop. Water meadows had been drained by the landlord who charged 5 per cent interest in the rent and the other grass land had been improved by feeding sheep with cake on it. All crops were heavily manured and modern machines were used, the Burgess and Key reaping machine, steam driven threshers, and a Fowler steam cultivating set since 1864. Seeds mixtures were carefully selected for grazing and manuring. No breeding was done. Alderney cows were however kept for household milk but all steers for breeding were bought for summer grazing. A flock of 400 breeding ewes were kept from Hampshire Down by Cotswold ram, and they again put to a Cotswold ram. Lambs were fed off at 10 to 12 months for the London market and ewes were bought every year as lamb, and the rams hired. Some 26 or 28 horses of the Norfolk and Suffolk breeds were kept.[34]

When the depression came other counties began to lay down land to grass but Clare Sewell Read of Honingham, Thorpe, Norwich, did not think that likely to happen in Norfolk "unless something dreadful happens to the price of barley" because the land is so light. He took wheat and then barley after two years seeds, but kept sainfoin down for from two to four years. He never mowed old pasture unless the seeds failed, and he helped by a good coat of dung or compost every year if possible. Two year seeds had a tendency to produce weeds and useless grasses, so he kept the land clean with a cultivator.[35]

Frederick Clifford in quite another connection[36] remarks upon the highly mechanized farming of East Anglia in 1874. The Newmarket Farmers' Association covered 42 parishes including Mildenhall and Soham. Reaping machines were in general use there. At West Thorpe there was a steam plow and scarifier, mowing was by horse mower, raking and gathering hay by horse power. Reaping machines and elevators, chaff cutters, cake breakers,

root pulpers, and a steam thresher were all to be found. "High farming upon large farms," he wrote, "means, in fact, an increased staff of hands, supplemented by the highest possible development of machine labor, operating upon a highly manured soil and repaid by more numerous crops and increased production."

As I have said Clarke did not report any changes in 1878 although he described Norfolk carefully[37] and Henry Overman, one of Lord Leicester's tenants who occupied 1300 acres at Weasenham, was farming on much the same lines as Hudson when he gave evidence to the Richmond Commission in 1881. As much or as little can be said for George Gayford of Lackford who was however a rather more pompous person.

Druce's report does nothing to disturb this conclusion. Norfolk was always a fine farming county and it maintained its reputation during the period 1840 to 1880. Improvements were introduced but of these there is no gauge. The livestock population from 1875 was:

	1875	*1880*	*1881*
Horses	58,667	63,840	63,127
Cattle	109,183	108,278	114,348
Sheep	728,588	638,791	579,691
Pigs	83,047	85,483	82,711

Suffolk

The system of farming practiced in Suffolk was described by Hugh Raynbird[38] in 1847 and by J. A. Clarke[39] in 1878, and no change is evident in the established rotations followed. As in Essex it was customary to plow the heavy land in stetches of 10 feet or 12 feet and these lands had been drained and the drill husbandry introduced by 1847. The course was a bare fallow or tares, mangels, or turnips; barley; half clover, half beans or peas; wheat; and this remained constant during the period. It was regarded as the best course for heavy land yet tried. Occasionally red clover was drilled in August, after the corn was off, and plowed in six or eight weeks later with a half dressing of muck.

On the light lands the 4-course was used, the root break being either swedes, white turnips, carrots, or mangolds. Breeding flocks were kept and some rye was grown for feed, tares and rape being sometimes mixed with it to provide a heavier growth, and the forward rye was cut green for soiling horses. This cropping was intensified on the rich loams by 1878, stubble turnips being largely grown on rye, white barley, or vetches to be followed by white turnips in the same year, and colewort or kohlrabi was often sown on the broken up clover ley.

The famous Suffolk butter and hard cheese dairies had gone by 1847, cattle being bought in autumn and fed on roots, grain, and cake, and compound feeds, and sold fat from February to June. The Suffolk Polls, the fine native dairy cattle, were fed in yards, and Galloways were bought although some farmers preferred Shorthorns. The sheep were mainly the old Norfolk crossed with Downs, but flying flocks of half bred Leicesters were kept.

The fens were farmed like those of Cambridgeshire and a good deal of grassland had been broken up since 1800 in much the same way. Great firms of implement makers had been founded in the county, as in Bedford and Northampton, some of which continue to flourish today.

Rham was particularly enthusiastic about the implement factories. In his opinion there was no part of England where the implements of husbandry were more perfect than in Suffolk or where new implements were tried with more readiness and with less prejudice.

Wheel plows were preferred and the list included scufflers, scarifiers, rollers and harrows, seed drills, threshing machines, winnowers, hummellers, root slicers, chaff cutters, cake breakers and bone crushers. Dibbling was the favorite way of sowing, but employed too much labor on large farms so seed drills were used. The then recent machines for dibbling were not well enough known by practical experience. Caird was equally enthusiastic about Ransomes of Ipswich, and Garrett of Leiston and Smyth of Peasenhall.

The county had its own breed of horses, the Suffolk Punch, a smallish bulky horse with great power on the collar. The Suffolk Red Poll was a famous dairy breed with an average yield of 16 quarts daily and the bulchins were either fatted or sold to Essex for finishing. The Suffolk pig, a good poor man's pig, was declared to be the most profitable in England.

Mr. Bond of Earl Soham, a fine farmer, got more than the natural average yield of wheat today, when he was in business in 1850, some 40 bushels an acre. Henry Kersey, agent to the Tollemache estate of 7000 to 8000 acres, told the Select Committee on Agricultural Customs of 1848 that the landlord had encouraged draining, chalking, and claying since 1840 by compensating his tenants for that work. R. B. Harvey of Flixton Hall, when giving evidence, had straightened the fences, tile drained a farm of 135 acres, clayed at 50 loads an acre, and filled up the ponds, since he had secured an agreement with his landlord to protect him against loss on this class of work.

William Mansfield of Ixworth Thorpe near Bury St. Edmunds and Herman Biddell of Playford near Ipswich gave evidence to the Richmond Commission in 1881. Both occupied large farms and they confirm the impression that the good farming of the county had been maintained, and Druce's Report does the same, but, of course, there is no measure of what had been done. Perhaps this county did not suffer such severe livestock losses in the 1870's as some others as the following figures indicate:

	1875	*1880*	*1881*
Horses	42,022	43,571	43,505
Cattle	65,316	58,033	63,837
Sheep	475,911	448,731	419,947
Pigs	111,373	115,615	115,75

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POTENTIAL AREAS OF CACAO CULTIVATION IN SOUTH AMERICA: A REVIEW

Olof Jonasson

Professor Jonasson of the Geografiska Institutet at the University of Commerce, Göteborg, Sweden, has specialized in agricultural geography. Several of his articles appeared in early issues of this magazine.

IN a recently published Swedish dissertation by Ivar Erneholm* dealing with the problems of cacao production in South America—in the past, at present, as well as in the future—the most important chapter, scientifically, is the one in which "Potential Areas of Cacao Cultivation in South America" are discussed. To the reviewer this part of the book is of particular interest as he himself has made similar investigations throughout the world concerning certain crops, such as "the small grains," coffee, and, though more briefly, cacao. Quoting from the article on coffee culture:

> Few problems confront the economic geographer with such urgent need for solution as the relationship between the cultivation and distribution of an important crop on the one hand and on the other its physical demands upon the land it occupies. Upon this problem depends in large part the economic exploitation of our world, whether it concerns itself with agriculture, the mining and winning of raw ores, industrial activity, or the like. Pressing as the problem is at the moment, our exact knowledge of the elements for its solution is correspondingly inadequate; not only because of the multiplicity of the factors that generally affect the distribution of the crop and its yield and quality, but also because of the whole complex of conditions which in this most intimate interdependence and interrelationship are exceedingly difficult to resolve into their several effects.[1]

*Ivar Erneholm: Cacao Production of South America. Historical Development and Present Geographical Distribution. 279 pp.; maps, diagrs., bibliogr. C. R. Holmqvists Boktryckeri AB., Göteborg, Sweden, 1948. $12.00.

In limiting his potential areas of cacao cultivation Erneholm claims to have used three lines of demarkation: "Cold limit," "Dry limit," and "Distribution of Escoba de Bruja." The use of the spread of Escoba de Bruja (in English usually called Witch's Broom) for limiting potential cacao growing areas might be disputable. Dangerous though this disease may be, especially in South America, it is not the only one destroying cacao, and the possibility exists that Escoba de Bruja can be combatted if other factors are favorable.

Erneholm summarizes the factors affecting the so-called *cold limit* as follows:

> . . . the cultivation of cacao on a commercial scale can only take place in areas where the mean minimum daily temperature during the coldest month does not sink below 15° [centigrade], the absolute minima not under 10° as a rule, and never to 0°, and the annual mean temperature is not under 21°.[2]

In discussing the *dry limit* he makes the following statement:

> Even with an optimum distribution of rainfall during the year there is nowhere cultivation of cacao without irrigation if the annual rainfall sinks below 1,000 mm. The isohyet 1,000 mm as an average for the year may thus be regarded as an absolute dry limit in such areas.[3]

Farther on he adds:

> The dry period line of 4 months seems, therefore, to mark the dry limit in areas with more than 1,000 mm annual rainfall.[4]

On the basis of these two limits plus the occurrence of Witch's Broom Erneholm constructs his "Potential Areas Without Irrigation and Not Affected With Escoba de Bruja."

According to the map accompanying Erneholm's book, cacao production should be possible, generally speaking, over the entire northern part of South America to approximately 10° S. latitude. To this may be added the coastal region in the state of Bahia, where the area for cultivation may be extended to 20° S. latitude. But the areas along the Andes as well as the highlands of Southern Venezuela must definitely be excluded due to adverse temperatures. In large parts of northeastern Brazil, northern Venezuela, and southern Ecuador precipitation is insufficient. Irrigation would there become necessary for cacao cultivation. To this it should be added that the greater part of the area of potential cultivation, such as the Amazon basin, is contaminated with Escoba de Bruza. The only remaining potential areas are those in eastern Brazil and certain valleys in Venezuela and Colombia, where suitable precipitation and temperatures seem to exist and where Escoba de Bruza has not spread. Broadly speaking, these areas coincide with South America's most important cacao regions of today.

The reviewer wishes to point out that the usage of the isotherm of the average annual temperature of 21° C. (70° F.) is questionable. This isotherm runs through warm temperate zones rather than through the tropical zone, and hence through regions where it is known that cacao is not grown and never can be introduced.

It is, however, evident that Erneholm in constructing his potential cacao growing areas has used, also, some isohyets, just as the reviewer has done in regard to similar areas for the growing of coffee when temperature figures were not available or were incomplete. In mountainous regions Erneholm's map corresponds very closely with the South American map in the Atlas of the Italian Tourist Bureau.[5] They are on the same scale. Also in other regions than in the highlands Erneholm has been compelled to make use of some altitude curves. To quote:

> From sea-level about half a degree of latitude south of Vitória the cold limit for the cultivation of cacao rises successively along the coast of Brazil, with diminishing distance from the equator, to about 500 meters in the Ilheus district, and about 800 meters in the latitude of São Salvador. The cold limit in these areas is marked in most cases by the isotherm 15° for the mean minimum daily temperature during the coldest month.[6]

Hence, even here Erneholm has used sources and adopted methods without referring to his sources of information.

The foregoing, and other examples not mentioned here, do not correspond well with Erneholm's own critical judgment of the research works of others or of official statistical data. In discussing the *cold limit*, he categorically states:

> No close investigations have yet been made to determine the cold limit for the cultivation of cacao and for that reason we find the most varied opinions on the subject in literature. Our investigation cannot, for this reason, be based on earlier researches, but must be based entirely on specially collected primary material and the author's own field studies.[7]

One wonders why "primary" statistical data compiled by official authorities should not be preferred to Erneholm's own compilations. In addition, how has it been possible for a single man during a short time to make field studies of natural factors affecting cacao production in an area covering a whole continent?

Generally speaking, Erneholm has not shown on charts for each country exactly how he has constructed his potential cultivation areas. Neither has he stated his sources of information, "primary" or otherwise. On the whole,

Erneholm's potential area for cacao cultivation appears very startling. In "Revista Brasileira de Geografia" Brazilian authorities make the following announcement (in translation):

> In Brazil the annual average temperature necessary for growing cacao is between 24° and 28° and the corresponding minimum temperature 18° to 20° C.[8]

And in regard to the requirement of rainfall the following statement appears:

> It must be secured by a yearly amount of precipitation lying over 1600 mm and below 1800 mm with a regular distribution through the year, from which the conclusion may be drawn that the cacao tree will thrive well in humid areas without seasonal variations. As temperature and humidity are influenced by the altitude, this third factor must also be considered. As a matter of fact, these trees prefer the low regions of the "varzeas."[9]

The above mentioned climatic stipulations for Brazilian cacao growing do not agree very well with those stated by Erneholm. They coincide closer to the reviewer's rather loosely founded basic factors given in "Cacao in the World's Commerce,"[10] i.e., an annual average temperature of at least 24° (75° F.), 2000 mm. (80 inches) annual precipitation (too high), and tropical rain forest. Most remarkable among the Brazilian statements are the low values given for precipitation and the apparent existence of higher limits for both temperature and precipitation, closest resembling what the reviewer called the "limit for heat-humidity" in his work on coffee.

The reason the wet limit for growing cacao has been set as low as 1800 mm. for the annual amount of precipitation is probably to be found in connection with cacao plant diseases. Everywhere in cacao literature and in various cacao regions it has been pointed out that the plant diseases are more common in areas with abundant rainfall. This is probably the reason cultivation under irrigation has increased during recent years. It has not been directly brought out in Erneholm's book, but earlier statistics compared with his figures for recent years point to the fact that this is the case in regard to the Bahia region, where about 90 per cent of the cacao of Brazil is produced. Within this region the Ilheas district is the most important. The annual precipitation there is the heaviest in the state of Bahia. In the coastal areas it amounts to about 2000 mm. (80 inches) per year. On the whole, the cacao areas appear to have decreased there during recent years, as stated before. This decrease may be due to other circumstances, such as competition from other cultivated plants (sugar, tobacco, cotton, coffee, cassava, etc.) or from other industries. As an example, it has been reported that the cacao growers in Venezuela are generally complaining about the competition on the labor market caused by the petroleum industry. Erneholm does not touch on this problem.

The possibilities of growing cacao on the west coast of Columbia appear slight, as the average annual precipitation there reaches at least 7000 mm. (280 inches) and may some years be more than 10,000 mm. (400 inches). While it is realized that some heat-humidity limit may exist for growing cacao, this can hardly lie either as low as the isohyet of 1800 mm. (70 inches) or as high as 5000 mm. (200 inches) per year.

In this connection it is to be noted that the potential areas for cacao cultivation are, according to Erneholm, areas where cacao can be grown "on a commercial scale."[11] Thus the wild cacao plant is not being considered, nor any small scattered plantings that may be abandoned after a few years for one reason or another.

The reviewer wishes to warn against excessive use of too one-sided factors

for indicating possibilities for growing a certain crop. It would be better to use good investigations showing vegetation or climatic soil types as a basis for opinions because soil (to a less extent, natural vegetation) in this respect signifies the synthesis of all important natural factors. Erneholm has not attempted anything in this connection.

Among natural factors more or less affecting cacao production the following may be listed:

GENERAL FACTORS

Temperature limits
Low Temperature—cold limit
High Temperature—hot limit
Rain limits
Dry limit
Wet limit
Moisture limitations, such as heat-humidity limit
Altitude limits (upwards as well as possibly downwards)

LOCAL FACTORS

Geological foundation
Loose sediments
Soil exhaustion
Natural vegetation
Topography
Soil erosion
Drainage
Natural irrigation
Winds and storms
Cloudiness (shading)
Plant diseases
Destruction by insects, etc.

It is not sufficient to deal with production alone, as such. It must be viewed in connection with the market by way of distribution. There are consequently many economic factors—local, national and international—which will influence to some degree the production of cacao in the various areas of cultivation in the world. These factors are not less important than natural conditions when discussing cultivation, especially when considering its intensity. Erneholm has neglected this viewpoint.

At the last international cacao conference, in London, 1948, Manuel Palma (Ministry of Agriculture, Venezuela) pointed out:

> It is my opinion that the future of cacao, not only in Venezuela, but throughout the World, depends on one factor: prices.[12]

He had previously called attention in detail to the danger of plant diseases, the importance of which has been exaggerated by Erneholm.

Even though Erneholm's study has its shortcomings it is a contribution to our knowledge of the cultivation of cacao in South America. But much still remains to be done before an adequate picture is available as to the manner in which cultivation and yield vary with the physical factors affecting cacao growing and how cacao production depends on economic, social, political, and other conditions. To achieve clarity on these points, not only detailed experimentation in many fields and over wide areas is needed, but also accurate research and measurements of the most important factors affecting cacao.

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2. Erneholm, *op. cit.*, p. 264.

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BOOK REVIEWS

Conservation of Natural Resources. Edited by GUY-HAROLD SMITH. xii and 552 pp.; maps, tables, bibliogr., index. John Wiley & Sons, Inc., New York, 1950. $6.00. 9¾ x 7⅜ inches.

It is the understanding of this reviewer (possibly erroneous) that the publishers and editor of *Conservation of Natural Resources* would like to have the volume regarded as a successor to, rather than a revision of, *Our Natural Resources and Their Conservation* edited by A. E. Parkins and J. R. Whitaker. In the preface, however, the editor refers to it as a "revision." Certainly most readers will examine the new volume in comparison with its familiar predecessor. The reviewer, for example, discovered that what he regarded as the finest chapter in the older volume had been replaced by one of the weakest chapters in the new work. Contrariwise, Wolfanger's revision of his chapter on "The Great Soil Groups" is a solid success. It is now one of the finest introductions to the characteristics and significance of the soils of the United States available in so short a discussion. Each reader will make his own comparative appraisal.

The new volume is sufficiently different, nevertheless, to be judged on its own merits. Almost every chapter has been revised to a greater or lesser extent and several chapters, by both new and old authors, are completely new both in organization and treatment. The new book has a larger page size and double columns of text. The larger pages permit a decided improvement in the illustrations. The overall organization has been modified only slightly.

The great weakness of the text lies in its unbalance—its concentrated preoccupation with physical techniques of conservation. Conservation or resource management has two basic aspects; one is physical, the other cultural. One phase deals with problems of how to manage or conserve resources; the other with problems of getting resources managed or conserved. Each aspect is of equal importance. *Conservation of Natural Resources* concentrates on the former.

On matters pertaining to the physical techniques of conservation the authors do an excellent job. Not only have they conscientiously covered the principal points, they have also taken considerable pains to point out which matters are of critical and which of lesser importance. Possibly the best treatment of any subject is that of the resource situation. Each author has carefully and ably summed up the situation with regard to each particular resource as regards present supply, extent of depletion, and relation to demand. Moreover, the relationship between resource supplies and technology is discussed in enough different contexts so that only a particularly dull reader will fail to grasp the significance of this important concept.

On matters relating to the social or cultural problems of effectuating conservation techniques the picture is much less satisfactory. Economics receives only the most cursory acknowledgment throughout almost the entire volume. There are references to costs of technical processes and occasional references to comparative costs at different periods, but discussions of the real economic problems are conspicuously absent. Chapter after chapter describes the role played by the Federal, State, and local governments, special governmental units, or private enterprise in the conservation and management of our various resources. But almost invariably this arrangement is discussed as a given situation. The causes and the results of these methods of organization are rarely considered; even less attention is paid to the results of the organizational tensions and pressures that exist, and analyses of alternative social organizations for managing the resource are almost wholly lacking.

The discussion of floods and flood control offers an excellent illustration of both of the foregoing points. A 28-page chapter on flood control in the United States contains not one single mention of the U. S. Army Corps of Engineers, and the closest it approaches a discussion of the benefit-cost ratio is a single quotation recommending that federal contributions to flood control be withheld unless " 'the total benefits justify the expense.' " The reader can judge whether or not an adequate discussion of problems related to flood control in the United States is possible without a more extended discussion of these two topics. Similar examples could be given from many other chapters; but, it must be added, a few chapters are notable exceptions. In the various reviews of the history of the management of the various resources the foregoing points are considered much more adequately.

Conceivably, if all these matters had been treated the book would have exceeded practical size. Actually, much information in the various chapters is largely gratuitous and could easily have been eliminated had space considerations been important.

Viewed as a comprehensive introductory textbook on resource conservation the volume is not very good. Nevertheless, it certainly is as good a text as is available and quite possibly the best.

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